POWER PLANT ENGINEERING

GENERATION, TRANSMISSION AND UTILIZATION OF STEAM, ELECTRIC, DIESEL AND HYDRAULIC POWER

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DECEMBER
1938

Vol. XLII., No. 12

Published on the first of each month, copyright 1938 by the
Technical Publishing Co., 53 W. Jackson Blvd., Chicago.
New York Office, 171 Madison Ave.

EDITORIAL STAFF: ARTHUR L. RICE, Editorial Director R. E. TURNER, Editor.
A. W. KRAMER, Electrical Editor RICHARD H. MORRIS, Engineering Editor.

Subscription price. U. S. A. $2.00 a year; other countries, $3.50 a year. Single copy current issue, 25c; other countries, 35c. January issue, U. S. A., 50c; other countries, 60c. Back issues, single copy, U. S. A., 40c; other countries, 50c. January issue, U. S. A., 75c; other countries, 85c.

Member, Associated Business Papers. Audit Bureau of Circulations.

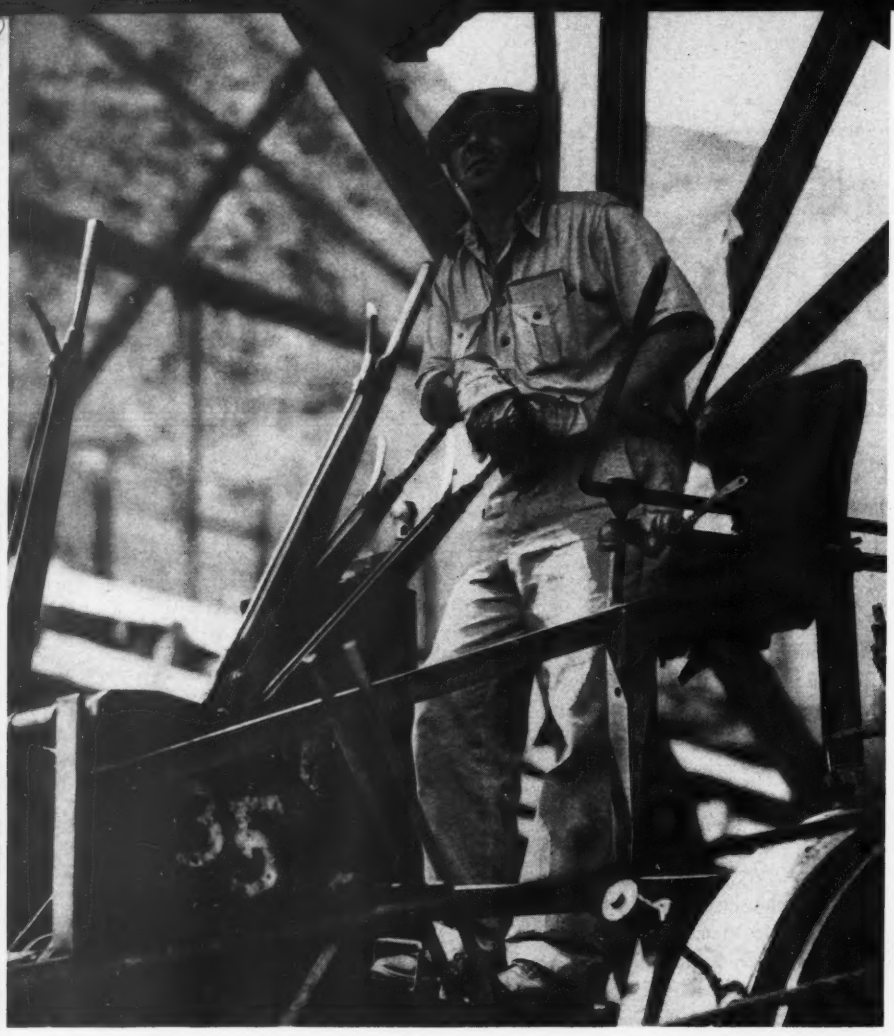


Photo. Bureau of Reclamation

He Symbolizes Our Age

STANDING IN HIS CAB, surrounded by his levers and electric controllers, this operator at Grand Coulee represents something more than an element in the work of bringing the great Columbia River project to completion. As he stands there, at ease, yet alert, watching for the signal to set the machinery in operation, he symbolizes the age we live in—the "Age of Power." At the touch of his hand, steel girders weighing scores of tons will move and be guided smoothly and delicately into place. ¶ It took 100,000 men twenty years to build the Great Pyramid of Egypt. By the aid of these levers and the power under their control 6000 men will build Grand Coulee Dam in seven years; and Grand Coulee Dam will be three times the size of the Great Pyramid. In this comparison between the ancient civilization along the Nile and our own, lie the implications of our power age. ¶ Many engaged in the production of power take the external aspects of our power age for granted and do not stop to consider how greatly the wide use of power has changed the world, not only physically but socially, politically, religiously and perhaps philosophically as well. This is no reflection—after all there are only 24 hours in a day and most of us have too much to do to give much concern to the external aspects of our work. However, as editors, we are in a more favorable position to appraise the field as a whole and to study its influence in the pattern of our existence and so, in the forthcoming January issue we shall discuss this whole subject of the relation of power to the world in general in considerable detail. The entire January number, in fact, will be given over to this subject—the significance of power in the modern world and while we probably will not say anything that has not already been said before, we believe that our treatment of the subject will be of interest to everybody from the lowliest coal passer to the highest executives in the business.

WITH THE EDITORS

In The Wake of Research

WHEN the good ship Research sails the seas, she reveals in the surging turmoil of her wake many secrets that Dame Nature has been hiding since the beginning of time. In the scintillating foam, men with vision have had glimpses of the pearls of progress and, capturing these treasures, have constructed our present day civilization.

Within the week two experiences of the writer have almost compelled him to make the above statement. These were a visit to the Museum of Science and Industry and a trip through the research laboratory of Crane Co. on the first day of its open house. At one place is portrayed what man has done, the steps he has taken from as far back in time as history records—successes, failures, advances, retreats, static stages, rapid developments. At the research laboratory, demonstrations were made of the instruments used by scientists to reveal information by means of which manufactured equipment can be improved in quality and performance.

Upon the foundation of the past we are building the structures of the future. Deeper and deeper goes our search for facts in regard to materials and forces, and their relations to other materials and forces. Higher and higher go the demands of human society for living conditions, both physical and cultural, thought, at the moment at least, to be more desirable. The human race seems never to become satisfied but must continuously seek the unknown, study the past, experiment for the future.

Thus was born the spirit of research, and its activities have resulted in the elimination of many human drudgeries of past generations and the establishment in their stead of physical comforts and mental delights.

Turning our thoughts from the academic to the practical phases of research which have been manifest during the past half century, we find coming to the front in our industrial and social life many of the basic laws of science which for long periods of time had been dormant.

Commercial application of the electric motor is less than 75 yr. old, yet today industry would stop and even homes would be thrown into confusion without the services rendered by power plants. Application of high frequency waves, such as X-ray, radio and radium rays, are responsible for entirely new industries as well as greatly improving the effectiveness of practically all the older industries. Until comparatively few years ago, alloys of metals were the results of accidental discoveries; today, as a result of research, metals are alloyed scientifically to predetermined quality specifications. Autogenous welding has been developed into an art that has almost completely replaced the old time blacksmith. The internal combustion engine with its application to automobiles and airplanes has revolutionized the transportation industry beyond the imagination of the prophets of 100 yr. ago, and the ramifications of this industry into other fields of activity are countless in number.

In the basic sciences, research is responsible for many changes in theories regarding physical and chemical laws which have resulted in more than doubling the number of recognizable elements and even to cracking the atom.

Following all these advancements in fundamental sciences, engineering has progressed steadily as will, no doubt, be evident to any visitor at the power show to be held this month in New York. Here will be found present-day applications of materials used in manufactured equipment; iron and its alloys, copper, lead, zinc, nickel and their alloys, ceramics of all kinds, refractories and insulating materials, rubber and other plastics employing the newer formulas. All these will be demonstrated as separate materials and as worked into the designs of industrial equipment.

Within the half century, industrial instruments have undergone revolutionary changes in many of which the new branch of science, electronics, has taken an extremely important part. Automatic controls for nearly everything including pressures, temperatures, speeds, combustion, chemical reactions and voltage are nearly all based on principles developed into practicable application since the turn of the century. Then too there are scores of new machines developed for present-day industrial use such as portable electric screw drivers, drills, grinders, lathes, saws, and tapping machines; electric rivet heaters, welders, markers and etchers; all representing some engineer's ideas for accomplishing purposes required in our industrial activities.

Temperatures and pressures have increased with advancing metallurgical development thus permitting employment of more efficient heat-power cycles. Electrical insulation improvements have permitted the use of higher voltages which in turn have reduced line losses, lengthened transmission distances and cut down copper requirements.

Truly, the spread of the waves in the wake of Research throws up benefits to the living conditions of every civilized human being.

Paper Mill Builds Modern

Northern Paper Mills of Green Bay, Wis., builds a new power plant with two 700 lb., 700 deg. F., 75,000 lb. per hr. pulverized coal fired boilers and two generating units totaling 5000 kw. Designed to operate with a balanced steam and power load, the new plant replaces an old 150 lb. boiler plant and hydroelectric power.

POWER REPRESENTS about one third of the total conversion cost in the manufacture of paper, and for this reason the construction of paper mills at water power sites has been inevitable. During the past 10 yr. the Northern Paper Mills have owned and operated two hydroelectric plants on the Menominee River and transmitted the power over a 132,000 v. steel tower transmission line 83 mi. to Green Bay. These hydroelectric plants furnished with an over abundance of power in the spring and fall and insufficient power the balance of the year. The manufacturing operation, however, is on a 24 hr. day, six day week, basis and as a result the power supply and demand did not fit. This incongruity of service resulted in the plan for a new steam power plant and the sale of the hydroelectric facilities.

Unlike a utility with condensing units that use but a third of the heat in coal, a paper mill, as a prerequisite, requires large quantities of low head heat in the cooking and drying process. For this reason, a high pressure extraction turbine furnishes electric power as a by-product.

With recent developments of high pressure steam plants, availability of coal rather than water power sites has become the important consideration. Fortunately, the Northern Paper Mills is strategically situated on the Fox River in the harbor of Green Bay and has twenty foot depth of water available at the dock adjacent to the coal storage pile. Self-unloading steamers carry 6000 to 8000 t. of Eastern coal and unload at the boiler plant at the rate of 1000 t. an hr. at a water transportation cost of 65 ct. a ton. Incidentally, pulp wood is delivered with the mill's own steamship from Canadian ports, and limestone, sulphur, and other commodities are also laid down on the dock at low water freight rates.

Present Power Plant

A brief resumé of the present equipment and operating conditions is important to appreciate the value of the new power plant. Since the sale of the hydroelectric property, all of the electrical energy used at Northern Paper Mills is purchased from a local utility. The existing boiler plant, with seven Sterling boilers equipped with Type E stokers, is operated at 150 lb. ga., and delivers approximately 125,000 lb. of steam per hr. This plant is about 25 yr. old and operates with an over-all efficiency of approximately 60 per cent.

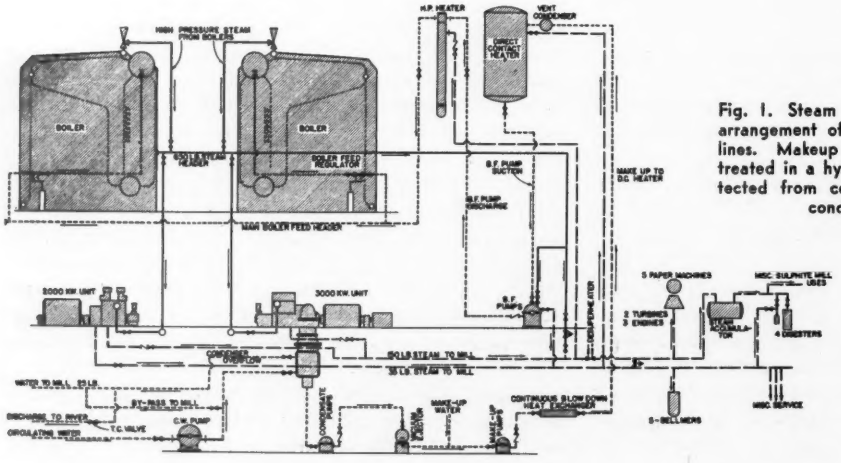


Fig. 1. Steam and water flow diagram showing the arrangement of the high pressure and process steam lines. Makeup which runs around 30 per cent is treated in a hydrogen zeolite system. Boilers are protected from contaminated condensate returns by a conductivity cell alarm system

Power Plant

By

H. W. GOCHNAUER

Chief Engineer
Northern Paper Mills
Green Bay, Wis.

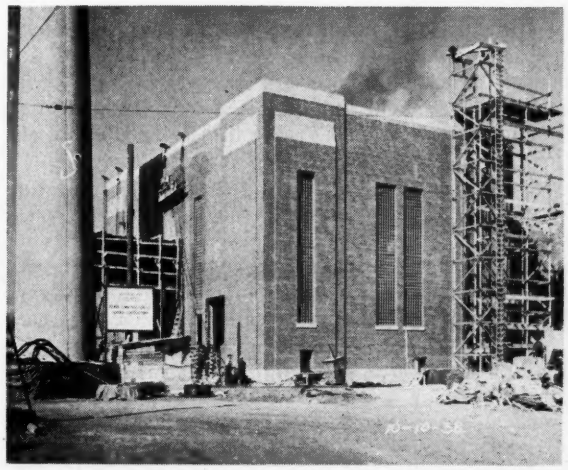


Fig. 2. Exterior view taken during construction. The plant site was formerly occupied by the office building which was moved several hundred feet to a new location, intact and while in service. The 225 ft. stack is, because of the small diameter and high wind pressure assumed, built with much more than the customary taper and its graceful outline more or less dominates Green Bay

With the advent of the new power plant, there will be but little change in the use of steam throughout the mills. At the present time, the sulphite mill is supplied with 150 lb. pressure steam through a Ruths steam accumulator from which the pressure is reduced to 110 lb. for digester cooking. This vessel has a storage capacity of 20,000 lb. of steam and levels all of the fluctuation in steam consumption. The result is a constant pressure throughout on the system. The accumulator will be a very valuable adjunct to the new plant, as the seven boilers with their respective steam drums will be replaced with two boilers, and the accumulator storage will equalize fluctuations in consumption.

Digesters are equipped with indirect heaters which allow the heating of the acid and its subsequent circulation by means of special acid resisting pumps. This method of indirect cooking eliminates the dilution of the acid, and thus conserves acid, gives a more uniform cook, and allows packing the chips in the digesters with a resulting increase in capacity.

The paper mill is supplied with 150 lb. steam which operates prime movers on individual paper machines, two of which are turbines and three steam engines. They are so designed that a balance is maintained between the steam requirements of the paper machine and the power requirements. These units act as reducing valves and deliver steam at the required pressure to the dryers. Inasmuch as several grades of paper are made on the various machines from time to time, a unit system of this type allows for the adjustment of the back pressure on the turbine or steam engine, with a range from a few to 30 lb. to afford the correct quantity of steam in the dryers of the paper machine. Condensate from the paper machine dryers passes through blast coil heaters, supplying hot air to the dryers, and thence to the condenser pump and back to the boiler plant. As previously stated, the heat of condensation is required in the process.

Steam at 150 lb. gage is occasionally used in the winter time for mill heating due to the fact that there is not sufficient low pressure steam for this service.

The new power plant building is of red face brick and built contiguous to the new beater room. The light green structural steel work and the darker green machinery blends very well with the interior design of the structure. The walls are of ceramic tile, straw colored to a height of about 8 ft. and cream from there to the ceiling. The floors are of terrazza and glass blocks are used in the windows. There is no dividing wall between the turbine room and the boilers. The firing aisle and powdered fuel mills face the turbines. Twin coal bunkers with a capacity of 120 t. each are designed with stiffening angles on the inside and these enhance the exterior appearance. The bunkers have been tested by filling with water and the utmost care has been taken throughout the design and construction to prevent the sifting of coal dust into the building.

Boiler Design

In the design of the power plant, considerable thought and study was given to the proper pressure and temperature. Estimates were made of plants designed for higher and lower pressures and careful heat balance studies were made of the steam and power requirements. As a result, it was found that the electric load and the steam load practically balance with the accepted design.

The same amount of coal used in the past to produce 150 lb. steam will be sufficient to operate the new plant, supply the same amount of 150 lb. steam, and in addition produce the electric power requirements. This situation is due to the fact that the increase in efficiency from about 60 per cent in the old plant to 85 per cent in the new plant will furnish enough extra heat to raise the pressure and temperature of the steam from 150 lb. saturated condition to 700 lb. pressure with 700 deg. F. total temperature. Less expensive coal can also be used in the new plant with powdered fuel firing as compared with the stoker firing in the old plant. Repairs and maintenance of the two units will no doubt be considerably less than maintenance of seven, 25 yr. old stoker fired boilers; and of course with the automatic combustion control and

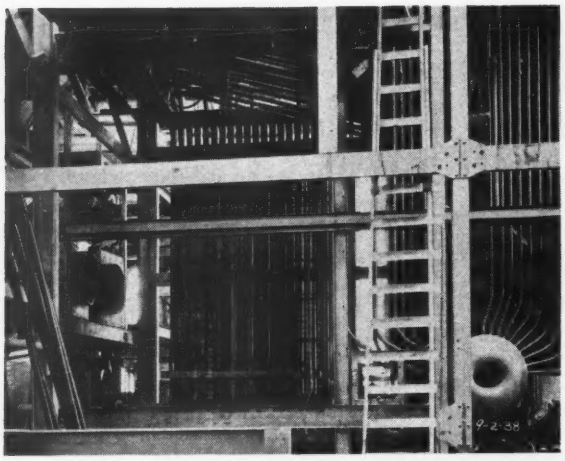


Fig. 3. Construction view of the boiler showing the boiler tube, side wall and burner arrangement. Each of the two 75,000 lb. per hr. boilers is fired by two pulverizers

a modern plant throughout, the operating labor will be very materially less.

In brief, two boilers have been installed with completely water cooled walls, designed for 700 lb. pressure and 700 deg. F. total temperature. Each is equipped with two mills and two powdered fuel burners. Oil ignition will be used to start the fire, and the oil burners are of sufficient capacity to generate 10,000 lb. steam per hr. per boiler if it is desired at any time to carry so light a load. More complete description of the equipment will be found tabulated in this article.

Two turbine generator units are designed for a pressure of 650 lb. at the throttle and 700 deg. F. total temperature. These units may be considered as being superimposed upon the old system, or, Topping Turbines, as they will serve as reducing valves in furnishing steam to the existing system. The 2000 kw. generator from the existing 150 lb. pressure turbo generator unit has been reconditioned and has been fitted with a new steam end. It is a non-condensing turbine designed with a 150 lb. extraction governor and exhausts at a manually adjustable pressure up to 35 lb. The second turbine is a 3000 kw. General Electric condensing unit, with an old condenser which has been retubed and redesigned. This unit also has a 150 lb. extraction governor for steam supply to the mill. In this manner, the entire demand for 150 lb. steam throughout the mill will be supplied from either or both of these units through their respective extraction governors. An automatically controlled desuperheater is installed in the header to hold down the superheat and thus protect the existing cast iron headers throughout the mill. Thirty-five pound pressure steam from the non-condensing unit will be conveyed through an existing low pressure header throughout the mill. This low pressure steam will be used in the sulphite mill for about 40 per cent of the requirements of the indirect heaters used in conjunction with the digesters. It will also be used in the low pressure feedwater heater and for mill heating and other services normal to a paper mill.

Although the steam and electric load are fairly well balanced, the condenser on the 3000 kw. unit will make it possible to produce electric power if the steam consumption should drop, and the reducing valve and desuperheater station included in the installation will provide makeup steam if the electric power requirements do not furnish enough steam through the turbines. Circulating water for the condenser is piped into the mill low pressure fresh water supply, and, inasmuch as the quantity of water required in the mill is a considerable amount, the condenser will always be supplied with sufficient cooling water to take care of any momentary amounts of steam that may pass through the turbine at times of peak electrical requirements. There is a bypass in the circulating water line from the condenser equipped with a temperature relief valve, so in event there is not sufficient water being used in the mill a slight temperature rise of the circulating water will operate the relief valve discharging the water into the sewer and maintaining sufficient flow through the condenser for its operating needs.

In this industry, a large quantity of make-up water is necessary and this becomes a factor in a high pressure steam boiler plant design. It is anticipated that it will be necessary to supply about 30 per cent make-

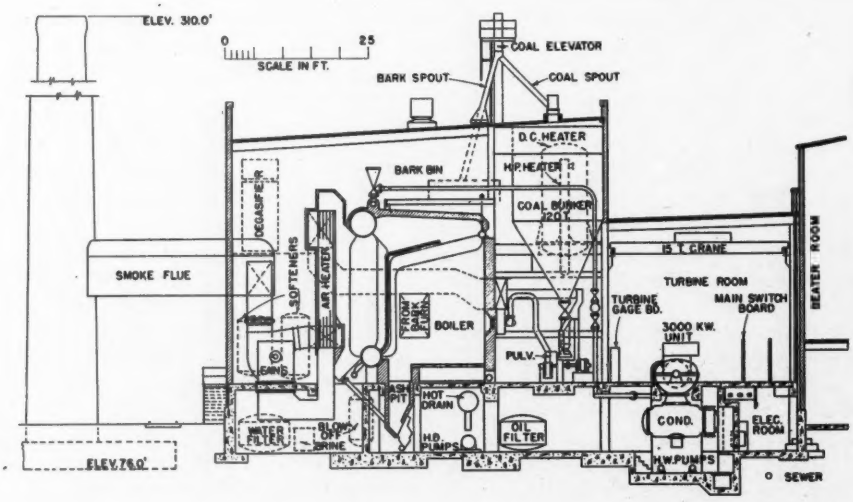


Fig. 4. Cross section of the new power plant. No curtain wall is provided between the boilers and turbines. Fans are located on the operating floor, both forced and induced draft fans being combined in a single unit drive

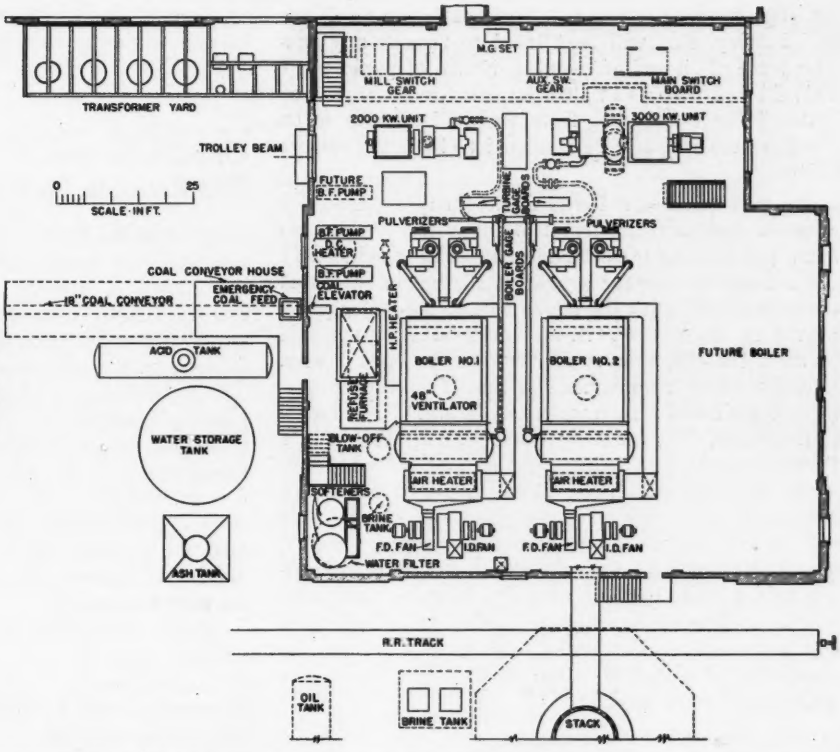


Fig. 5. The building provides space for a future boiler unit. Both coal and bark are brought into the plant on the same conveyor. Bark is burned wet in a special furnace located at the side of No. 1 boiler. Gasses of combustion enter the boiler furnace through the side wall

List of Principal Equipment Installed in the Power Plant of the Northern Paper Co., Green Bay, Wis.

Consulting Engineers, Sargent & Lundy, Inc.
General Contractors, Baker Construction Co.
Steam Generators. Riley Stoker Corp. Two, two-drum bent tube type, capacity each 75,000 lb. per hr., 675 lb. ga., 700 deg. F. at superheater outlet. Boiler 7000 sq. ft., water walls 2071 sq. ft., air heater 6300 sq. ft. Furnace volume 3850 cu. ft.

Coal Pulverizer. Riley Stoker Corp. Two per boiler, No. 4B Atrita units with feeders and magnetic separators. Cap. 4500 lb. per hr. each.

Bark Furnace. The M. A. Hofft Co. Furnace and feeding equipment for burning 6000 lb. of bark (66 per cent moisture) per hr.
Bark Hogger. Williams Patent Crusher & Pulverizer Co. Cap. 6 t. per hr.
Forced and Induced Draft Fans. Buffalo Forge Co. One set per boiler, each set consisting of one forced and one induced draft fan on a single shaft and driven by Allis-Chalmers motors 150 hp. on one end and 75 hp. on the other. Forced draft fan max. cap. 27,000 c.f.m. at 8.7 in. w.g. 100 deg. F., induced draft fan max. cap. 48,000 c.f.m. at 8 in. w.g. and 459 deg. F.

Conveyors. Robins Conveying Belt Co. One 18 in. belt conveyor from present track hopper to station (cap. 40 t. per hr.), and conveyor from bark storage bin to coal conveyor.
Coal Scale. Merrick Scale Mfg. Co. Belt Weightometer.
Water Columns. The Reliance Gauge Column Co.
Safety Valves. Consolidated Ashcroft Hancock Co., Inc.
Feedwater Regulators. Republic Flow Meters Co.
Blow Off Valves. The Edward Valve & Mfg. Co.
Soot Blowers. Diamond Power Specialty Corp.
Ash System. United Conveyor Corp. Pneumatic conveyor to outdoor elevated tank.
Chimney. General Concrete Constr. Co.
Feedwater Treatment. The Permutit Co. Zeo-Karb system with a capacity of 28,000 gal. in 7 hr. System consists of one 200 g.p.m. river water filter with Anthrafilt filtering element, one hydrogen and one sodium zeolite softening unit.
Oil Filter. The Permutit Co., cap. 120 g.p.m. for removing oil from mill returns.
Combustion Control. Republic Flow Meters Co.
Boiler Gage Boards. Republic Flow Meters Co.
Boiler Meters. Bailey Meter Co.
Recording Thermometers. The Bristol Co. Republic Flow Meters Co.
Feedwater Meter. Builders Iron Foundry.
Steam Flow Meters. Republic Flow Meters Co.
Piping System. William A. Pope Co., fabrication and erection.
Piping. Crane Co.
High Pressure Valve. Crane Co.
Desuperheater & Reducing Valve. Republic Flow Meters Co. Cap. 100,000 lb. per hr. from 675 lb., 700 deg. to 150 lb., 450 deg. F.

Turbo Generators. General Electric Co. One 3600 r.p.m., 650 lb., 700 deg. F., 12 stage condensing turbine, with controlled extraction at 150 lb. ga., driving a 3000 kw., 480 v., 0.8 p.f., 3 ph., 60 cycle generator and direct connected 125 v. exciter. Complete with single section 2340 sq. ft. generator air cooler designed to cool 9000 c.f.m. of air to 104 deg. F. when using 150 g.p.m. of 90 deg. F. water.

One 3600 r.p.m., 650 lb., 700 deg. F., 8 stg. condensing turbine, for 30 lb. ga. back pressure, driving a 2000 kw., 480 v., 0.8 p.f., 3 ph. 60 cycle generator from the old plant adapted to the new turbines. Complete with single section 2690 sq. ft. generator air cooler designed to cool 7000 c.f.m. of air to 104 deg. F. when using 120 g.p.m. of 90 deg. F. water.

Condenser. Foster Wheeler Corp. 2570 sq. ft. of surface using ¾ in. O.D. tubes. Capacity 33,000 lb. per hr., 5000 g.p.m. of water. Cast iron shell reclaimed from former 2000 kw. unit in old plant, modernized and rebuilt with expansion joint to permit rolling tubes at both ends.

Turbine Oiling System. S. F. Bowser & Co., Inc. Consists of 5 g.p.m. pressure filter; one 5 g.p.m. Viking filter pump driven by a G. E. ½ hp., 440 v., 1150 r.p.m. motor; one 18 g.p.m. Viking transfer pump driven by a G. E. 1 hp., 440 v., 1135 r.p.m. motor, and one 1500 g.p.m. two compartment tank.
Turbine Relief Valves. Atwood & Morrill Co.
Float Valves. Fisher Governor Co.

Switchboards. General Electric Co. Three, main control, paper mill feeder and station auxiliaries.

Circuit Breakers. General Electric Co., 440 v. on generators and feeder circuits.
Motor Controls. General Electric Co. and I. T. E. Circuit Breaker Co.
Control Battery. Electric Storage Battery Co.
Power Transformer. Electric Service Co., Pittsburgh, 2300/4000—460 v., 1000 kv-a.
Lighting Transformer. Westinghouse Elec. & Mfg. Co., one, 125 kv-a.
Deaerating Heater. The Hoppes Mfg. Co. Cap. 200,000 lb. per hr., water outlet temp. 275 deg. F.
H. P. Heater. American Locomotive Co. Vertical, closed type, cap. 200,000 lb. per hr., water outlet temp. 340 deg. F.
Blow Down Heat Exchanger. The Whitlock Coil Pipe Co. Three coils totaling 150 sq. ft. of surface. Cooling capacity 75,000 lb. per hr.
Boiler Feed Pumps. Worthington Pump & Mach. Corp. Two, 3600 r.p.m. centrifuges, each with a cap. of 400 g.p.m. at 1850 ft. head. One driven by a Moore 270 hp., 625 lb., 675 deg. F. single stage turbine exhausting at 35 lb., the other by a 300 hp., Allis-Chalmers 440 v. motor.
Circulating Water Pump. Worthington Pump & Machine Corp. One, capacity 5000 g.p.m. against 53 ft. head. Driven by a 100 hp., 1170 r.p.m., 440 v., Allis-Chalmers motor.
Raw Water Pumps. Dayton-Dowd Co. Two, capacity each 250 g.p.m. at 125 ft. head and driven by 15 hp., 3500 r.p.m. 440 v., Westinghouse motors.
Hot Drain Pumps. Dayton-Dowd Co. Two, capacity each 200 g.p.m., at 165 ft. head and driven by 15 hp., 1750 r.p.m., 440 v., Allis-Chalmers motors.
Makeup Pumps. Dayton-Dowd Co. Two, capacity each 200 g.p.m. at 165 ft. head, each driven by 15 hp., 440 v., 3500 r.p.m., Westinghouse Co. motors.
Bilge Pumps. Yeomans Bros. Co. Two, capacity 200 g.p.m. each at 30 ft. head. Driven by three hp., 1740 r.p.m., 440 v., Allis-Chalmers motors.
Acid Pumps. Worthington Pump & Mach. Corp. Two, capacity each 50 g.p.m. at 48 ft. head, driven by 2 hp., 1750 r.p.m., 440 v., Allis-Chalmers motors.
Brine Pumps. Worthington Pump & Mach. Corp. Two, capacity each 30 g.p.m. at 55 ft. head, driven by three hp., 1750 r.p.m., 440 v., Allis-Chalmers motors.
Tanks. Manitowoc Engineering Works. Three, treated water storage; boiler blowdown, and mill return.
Iron & Steel. David Architectural Iron Works.
Crane. Cleveland Crane & Engineering Co. 15 t., floor operated, span 28 ft. 6 in.

up. The condensate returns from the paper machines, mill heating, etc., will be filtered to remove any possible trace of oil and any contamination of paper pulp. This filtered water will then be delivered to the open heater. The condensate from the indirect heater on the digesters will also be returned to the low pressure heater.

In this instance a Leeds & Northrup conductivity recorder and alarm is installed to protect the boilers from possible acid contamination. The conductivity cell is located near the source of the condensate, and the meter itself with the alarm bell in the boiler plant providing about 1000 ft. of condensate return line between the cell and its delivery to the open heater. Suitable valves are provided so that if occasion arises, the contaminated return water can be speedily switched to the sewer. The make-up water will be treated in a Permutit hydrogen zeolite system and stored in an outdoor welded steel tank, 21 ft. in diam., and 24 ft. high, with a capacity of 60,000 gals. This storage tank will provide sufficient water for boiler supply when it is necessary to regenerate the softeners. It is interesting to note that the Permutit Co. is using anthracite coal as a filter medium in the condensate return filter and a charcoal zeolite in the softener to eliminate the possibility of dissolved silica which might result if a quartz sand were used.

Benefits of New Steam Supply

Mill operation will be benefited in being supplied with the steam from the new plant, for instead of having dry saturated steam, it will be superheated, eliminating a great deal of condensation in the delivery headers. This superheat will be an added factor in the operation of the prime movers and should increase their horsepower rating. The 35 lb. pressure steam will replace 150 lb. steam now being used for the first portion of the cook in the digesters, which will result in the additional advantage of power being produced through the turbo-generator from 650 to 35 lb. rather than 650 to 150 lbs. pressure.

The Northern Paper Mills has a groundwood mill unit comprising a 2000 hp. motor directly connected to two magazine grinders. The power plant has been designed for future expansion, and this extra capacity will be used to operate a portion of the groundwood mill on a continual basis with the entire groundwood mill loaded on Sunday. Such a program will provide slush stock continually to the paper mill and will be an aid in balancing the boiler plant operation which will approach a 100 per cent load factor throughout the week and furnishing sufficient load on Sunday for the continual operation of at least one boiler and turbine unit.

Actual construction on the new power plant was started May 2, 1938, and scheduled for completion December 15, 1938. Inasmuch as electrical power to operate the mill was being purchased a concerted effort has been made to better the date of operation with the result that the plant went on the line the middle of November at least a month earlier than originally scheduled.

Sargent & Lundy, Inc., of Chicago was the consulting engineer, and the Baker Construction Co. of Green Bay the general contractor.

One Up for the Old Reliable Spring Drive

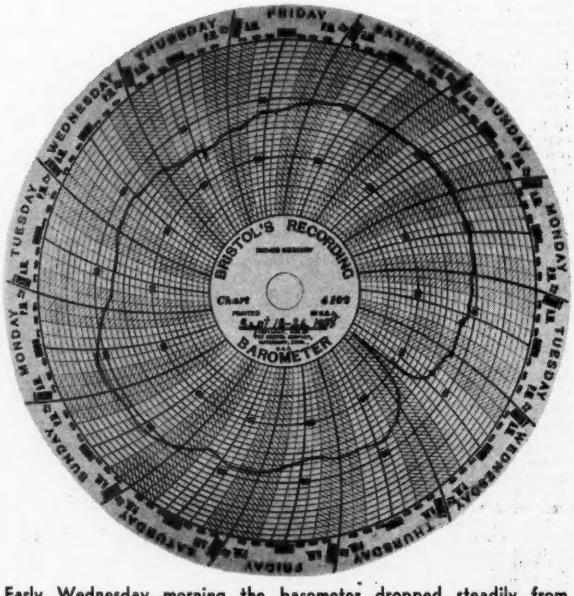
A Bristol Recording Barometer, operated by a spring-driven clock and mounted in the factory of the Bristol Company, Waterbury, Conn., predicted and faithfully charted the recent hurricane which swooped down on New England with devastating suddenness on the afternoon of September 21, 1938.

Equipped with a 14-day chart, this instrument continually recorded barometric pressure readings beginning Monday, September 12th at 8 a. m. With the exception of a low point of 29.50 in. from 6 a. m. to 6 p. m. the following Thursday, the 15th, the graph showed a comparatively steady atmospheric pressure of 30.00 in. until 1 a. m. Wednesday, September 21st, the day of the hurricane. Then the barometer began to act with a vengeance.

From a high 29.80 in. at that hour, the line dropped at high noon thirty hundredths of an inch to 29.50. And from noon to 6 p. m. there was chronicled on this barometer chart a drop in pressure to a point never before reported in the Waterbury, Conn., territory. In fact, the pressure line plummeted so deeply that it almost dropped off the calibrated portion of the chart!

Six hours later this pressure rose to 29.50 in. and by 9 a. m. the next day, September 22d, it was back to normal.

This chart, invaluable from a meteorological standpoint, will of course be preserved. The fact that the instrument making this record was powered by a spring-driven clock, enabled it to chart the atmospheric fluctuations throughout the entire storm.



Early Wednesday morning the barometer dropped steadily from 28.8 in. to a heretofor recorded low for Waterbury at 6 p. m. By the next morning it was nearly back to normal

Probability in the Power Plant

By EDWARD F. WILSON

CONTINUOUSLY being called upon to decide the advisability of accepting a new type of material, the power plant engineer must deal with probabilities. For example, he may be required to determine whether or not a new kind of packing is superior to the type now in use. Let us assume this is the case, and that the following test results were obtained:

	New Type	Old Type	Total
Satisfactory	8	22	30
Unsatisfactory	2	10	12
Total	10	32	42

A glance at these results indicates that the new type is probably slightly superior, since only 20 per cent proved unsatisfactory, while over 30 per cent of the old type fell in this classification. If there were a preponderance of cases either way, the conclusion would be obvious. But unfortunately in real engineering experience we are dealing with border line cases. It is seldom that in competing materials one is vastly superior to another. Not only this, but for economical reasons there are seldom enough trials permitted to compensate for "chance." It is this menace of chance that makes us doubtful about making a positive decision. Always, in the back of our minds, in spite of the numerical evidence in front of us, is the feeling "suppose it just happened." We cannot remove the effect of chance on our test results, but we can measure the effect of chance, and thereby reduce the doubt in making our decision. That is, for any sort of distribution of the numbers in the "cells" of our table, we compute the probability that such a distribution resulted from blind chance alone. Then if this probability is very low we can say, "The probability that these results 'just happened' is very remote. Therefore, there is probably a real difference in these materials," or "The probability that these results 'just happened' is very high, therefore, there is no evidence that the new material is superior."

Let us, first of all, make up "the most probable" chance table. This is not necessary for our computation, but is interesting, and in the theoretical derivation has some significance. To do this we simply prorate the amounts for each cell, as if there were no difference between the materials. For example, by pure, blind chance, of a datum falling in the Old type column is 32/42: of falling in the Satisfactory row, 30/42. Therefore, the probability of a datum falling in the Old Type-Satisfactory cell, is $32/42 \times 30/42$ or 960/1764. Since the total number of trials was 42, we multiply this amount by the chance fraction and get 23 (to the nearest integer) as the most probable chance number for this cell. The other three cells are immediately filled in by subtraction since the sub-totals play no part in the distribution, but remain constant.

CHANGE DISTRIBUTION

	New Type	Old Type	Total
Satisfactory	7	23	30
Unsatisfactory	3	9	12
Total	10	32	42

This distribution is almost identical with our test distribution, so we may immediately conclude that the test results are not sufficiently different from pure chance results to warrant saying there is any difference in the two materials at all.

In real life, however, the two tables are seldom so close as these two (chosen purposely for the sake of example), and it is necessary to compute a factor t, given below. Then by the use of the table of the probability integral, or that given in Mark's Mechanical Engineers Handbook, page 63 for residuals, we readily have the probability required.

The substitution in our formula for t can be facilitated by the following table:

FORMULA TABLE

	Test	Control	Total
Accepted	A	B	(A+B)
Rejected	C	D	(C+D)
Total	(A+C)	(B+D)	(A+B+C+D)

Then,

$$t = \sqrt{\frac{(AD - BC)^2 \times (A+B+C+D)}{(A+C)\,(B+D)\,(C+D)\,(A+B)}}$$

It will generally be found, when these figures are all filled in, that a good bit of cancelling out can be done.

Substituting our own figures gives t equal to 0.69. Comparing this with the table below, we see that the probability of getting the results here obtained by pure chance is almost a toss up. If t were 0.6745 the chances would be exactly 50-50. Hence we conclude that no evidence exists in this test to show that the new packing is superior to the old. In fact the test indicates they are both substantially the same, i. e., they both give the same service.

The probability figure taken from the tables is the probability the result obtained did not occur by chance. Or conversely, one minus this decimal would be the probability of obtaining our results by chance. The following is a brief table of the normal probability integral for values likely to be of use in power plant work.

t	Probability
.6745	.5000
1.0000	.6826
1.5000	.8664
2.0000	.9546
2.5000	.9876
3.0000	.9973
3.5000	.9996

If the table in Marks is to be used, t must be divided by 0.6745, or multiplied by 3/2, which is sufficiently accurate for this purpose. That is, using Mark's notation, $\frac{a}{r} = \frac{3}{2}\ t.$

A very close approximation to the values of this table is given by the formula $P = 1 - \frac{1}{n\,t^3},$ where n is approximately 3.1416, and t is greater than the "probable error," 0.6745. For t to be less than this, the results are plainly not significant, and the formula gives imaginary results, i. e., negative probabilities.

This application is a simplification of the chi-square method developed by the famous British statistician, Karl Pearson. It should be noted, however, that the idea behind it is not to measure exactly how much better, or worse, one material is than another, but whether the difference between their test results is "significant",—improbable by chance. The choice of a significant value of t is largely a matter of what is found to be economic in the particular plant. At least one very large laboratory, engaged in testing materials, has found 3 to be a practical value for t. In other words if t comes out to be 3 or larger, there is a definite difference in the quality of the materials tested.

Rope Reeved Grab Buckets

By C. L. HARRINGTON

Chief Eng., Bucket Dept.
Blaw-Knox Co., Pittsburgh, Pa.

CHAIN operation of grab buckets on high speed towers represents a long standing practice which has not endured without reason. High speed, two line tower operation is associated particularly with the unloading of ocean vessels and operators of high speed towers become skilled in casting the grab bucket beneath decks, thus enabling them to reach a large volume of cargo through a comparatively small hatchway. As a result of this characteristic method of operation, created by necessity, the grab bucket spends much of its time digging from an inclined plane, as illustrated by Fig. 1. When digging in this position the hoisting line is pulled through the head of the grab bucket at an abnormal angle thereto. Chain readily adapts itself to this abrupt angle of departure from the bucket whether casting to starboard or port.

On the other hand, grab buckets of the two line cable reeved type have not, generally speaking, been designed to comply with the requirements peculiar to such operating conditions. The conditions under

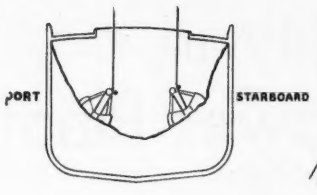


FIG. 1

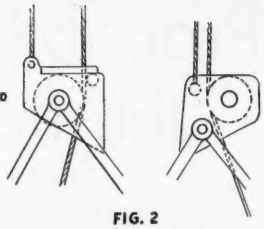


FIG. 2

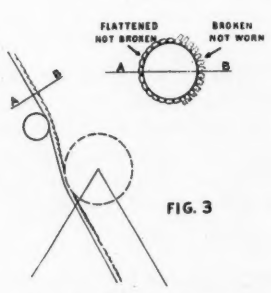


FIG. 3

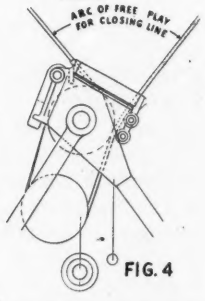


FIG. 4

Fig. 1. Grab bucket being loaded on inclined surface. Fig. 2. Typical rope reeved bucket heads. Fig. 3. Appearance of used cable. Fig. 4. Design of head with two guide rolls

which the cable enters the head of the conventional rope reeved bucket are typified by Fig. 2. In the port position (Fig. 1) the closing line leads the head sheave in a normal and satisfactory manner. In the starboard position, however, the closing line leads over a small guide roller or collar in such a manner as to cause excessive cable wear and early failure. After short usage, the cable appears as illustrated by Fig. 3: The outside wires are flattened but not broken, due to pressure in contact with the guide roller; the inside wires are broken but not worn due to bending over the roller.

From these considerations, it is evident that the use of a cable reeved bucket on high speed two line towers is essentially a guide roller problem. This has been the basis in attacking this problem, and Fig. 4 illustrates the design evolved by the Blaw-Knox Co. to achieve the desired aim.

The development involves the use of guide rollers located at a much lower elevation than is usual, thus allowing for a free play of about 70 deg. for the closing line. Two guide rollers are used instead of one in order to split the angle of impingement in the event that the closing line should pass through an arc of more than 70 deg. in relation to the bucket.

This practical solution to a very old problem should make available to high speed tower operation the many economies that are being realized from modern light weight alloy steel bucket design. It must be borne in mind, of course, that larger capacity but lighter weight buckets must possess greater digging power—another phase of bucket design study—to compensate for reduced weight; also that chain for equal strength weighs about 800 per cent more than cable. In short, the use of heavy chain cannot be reconciled with the modern practice which endorses the use of light weight alloy steel grab buckets. On the other hand, rope reeved grab buckets must be suitably designed for the requirements of high speed tower operation and solve the problem of excessive cable wear.

The feed water heater is not a particularly exciting piece of power plant equipment. It has none of the dynamic qualities of the spinning turbine and it is usually tucked away in some obscure corner where it is least conspicuous; fundamentally, it is nothing but a kettle for heating water. But it is important and is the turbine's staunchest partner in the everlasting combat against heat loss. In this article and the one to follow, Mr. Keller, who still holds the stage in the Modern Turbine Series, discusses in detail the part played by the feed water heater in a modern turbine plant and shows how its performance can quickly and accurately be estimated.

MODERN TURBINES*

By
ALLEN KELLER
Turbine Engineering Dept.
General Electric Co., Lynn, Mass.

DID YOU KNOW that the modern steam turbine power plant makes an 8 to 10 per cent saving in coal pile efficiency by the use of feed water heaters? And, did you know that the size of this gain can be estimated quickly and accurately without elaborate calculations or involved reasoning? In this article simple charts will be presented from which the benefits of feedwater heating may be read directly. Furthermore, the background for these charts will be discussed in language that is easy to understand. The whole subject will be treated from the standpoint of common sense.

In modern industrial power plant design, the trend towards higher steam pressures and temperatures is continuing unabated. This trend is largely due to the never-ending quest for higher and higher station efficiencies. As the design pressure is increased, the fuel which may be saved by feedwater heating also increases, so that under present day conditions a power plant study in which feedwater heating is not carefully considered is incomplete. In some power plants, a careful investigation may show that feedwater heating cannot be justified, however, the question should be given consideration in every case and the final decision based on all facts.

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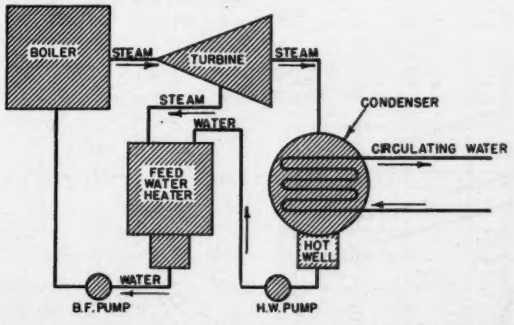


Fig. 1. Schematic diagram of a simple power plant employing one stage of feedwater heating

The subject of feedwater heating will be developed in this article along the following lines:

1. A general discussion of what is meant by feedwater heating.
2. Simple charts showing the efficiency gain resulting from the use of one or more feedwater heaters, together with illustrative examples.
3. A commonsense discussion of the theory underlying the various charts and their development.

For the purpose of making a detailed study of the feedwater heating possibilities in a particular case it will be necessary to read only to the end of the second section. It is believed, however, that every reader will want to read the third section discussing the theory of feedwater heating; that it will be in language which everyone can understand; and that most readers will get a better insight into the feedwater works and the reason it works that way.

What Is Feedwater Heating?

When a teakettle is placed on a stove and its contents allowed to boil away, the phenomenon is separated into two distinct phases: first, the water is heated, without boiling, from its initial temperature to the boiling point, and second, the hot water is con-

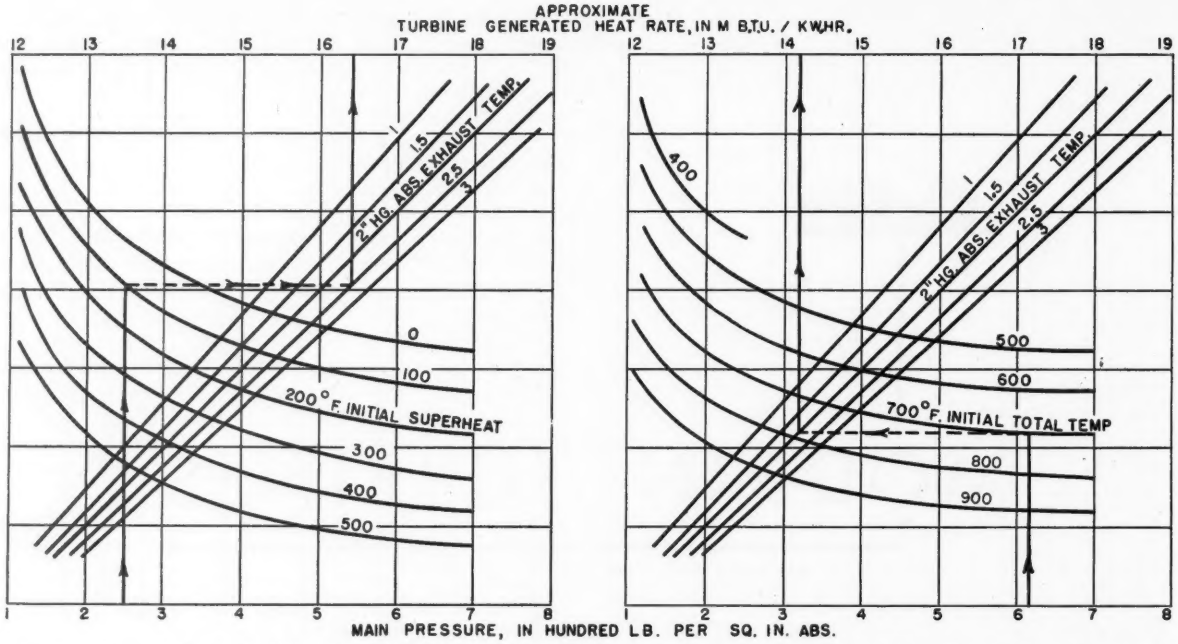


Fig. 2A and B. Approximate full load heat rate for 2000 kw. condensing turbine-generator sets operated without extraction for feedwater heating

NOTE: In this and in the other charts in this article, absolute pressure in lb. per sq. in. = lb. per sq. in. gage + 15 lb. per sq. in. (at sea level). Absolute pressure in inches Hg. = 30.0 minus the vacuum in inches Hg. at sea level)

verted into steam. Now, if we are in a hurry to get a room full of steam, the action may be accelerated by filling the teakettle with hot water instead of cold, for the obvious reason that it requires less heat to make steam from hot water than from cold water. In other words, we may employ feedwater heating.

Feedwater heating consists of heating the water supply to a boiler before it enters the boiler (or economizer).

In an actual power plant, the heat required for feed water heating might be supplied by a separately fired water heater or by steam withdrawn from the boiler itself. Obviously, there would be no overall plant fuel saving by so doing; one might as well burn fuel in the boiler to heat the water as to burn it in a separate water heater. On the other hand, suppose the feedwater is heated by steam extracted from an intermediate stage of a steam turbine, then power will be developed by the steam used for feed water heating. Moreover, this additional power generated by the extracted steam will be produced at a very high efficiency,

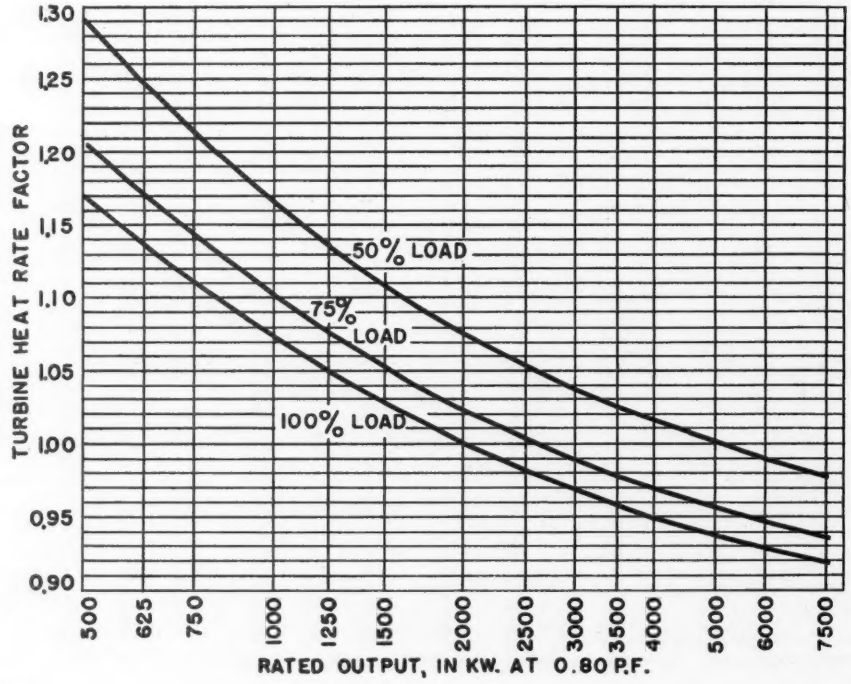


Fig. 3. Heat Rate factor for condensing turbines. Approximate turbine generator heat rate = full load heat rate for 2000 kw. set (Fig. 2A or B) × heat rate factor see Fig. 3 for heat rate factor

which will appreciably increase the average efficiency with which the total power output is generated.

Why does this extracted steam produce power at a much lower fuel cost than that of power produced by steam flowing to the condenser?—In the best modern condensing turbine power plants, approximately 2/3 of the heat present in the steam at the turbine inlet is left in the steam at the exhaust. Even were it possible to have a 100 per cent efficient turbine, the amount of heat thrown away at the exhaust would not be greatly reduced. This means that, at best, only about 1/3 of the heat in the fuel can be turned into power, the other 2/3 having to be thrown away at the condenser. On the other hand, none of the heat in the steam extracted for feedwater heating is wasted; the heat remaining in this steam is all absorbed by the boiler feedwater where it decreases, B.t.u. for B.t.u., the heat which must be supplied by the boiler. In other words, of the steam flowing from the throttle to the condenser, about 2/3 of the heat will be thrown away, while of the steam flowing from the throttle to an extraction opening, no heat will be wasted. It follows directly, then, that the more power that can be generated by extracted steam, the higher will be the average plant efficiency. Of course, the amount of steam which can be used for feedwater heating is determined by the amount of heat required to raise the temperature of the boiler feedwater, which places an upper limit on the efficiency gain which can be made by using feedwater heating.

For feedwater heating to effect an improvement in station efficiency, it is necessary that the feedwater be heated by steam extracted from the turbine after it has passed through part of the turbine stages and has done work.

It will not be within the scope of this article to discuss the design details or the relative merits of different types of feedwater heaters. Our primary interest is in evaluating the efficiency gain resulting from the use of feedwater heaters and all the schemes commonly used give approximately the same efficiency gain. Practical considerations and local conditions largely determine the exact arrangement which will be best for any particular power plant.

Figure 1 shows a schematic diagram of a simple power plant employing one stage of feedwater heating.

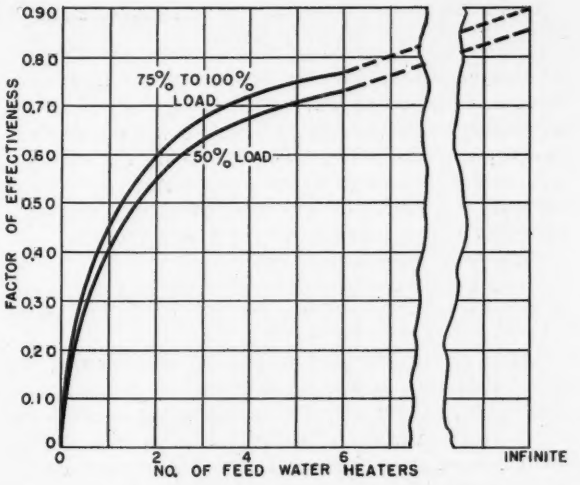


Fig. 5. Actual fuel saving by feedwater heating relative to theoretical saving for heat arrangement of heaters.

Briefly stated, the operation of this plant is as follows: Steam from the boiler enters the turbine and flows through the turbine stages generating power. Most of the steam passes through the complete turbine and is exhausted to the condenser, however, a part of the steam is extracted from a suitable stage of the turbine at a pressure and temperature higher than at the exhaust. The steam exhausted from the turbine contains about 2/3 of the heat it contained at the turbine inlet. This heat is removed from the steam by the condenser, converting the steam to water. The water is then pumped back into the boiler to be again converted into steam. Before entering the boiler, however, the water is passed through a feedwater heater where it is heated by the steam extracted from the turbine.

If more than one stage of feedwater heating is used, steam is extracted from the turbine at a number of points and fed to individual feed water heaters connected in series, each of which raises the temperature of the feedwater somewhat higher than the temperature at which it left the preceding heater.

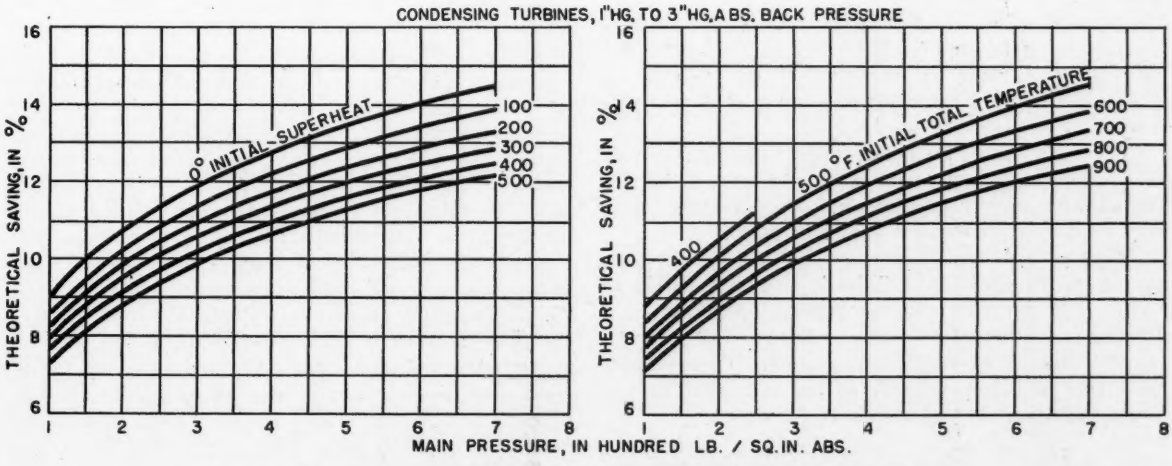


Fig. 4A and B. Approximate theoretical fuel saving resulting from feedwater heating

The Fuel Saving Effected by the Use of Feedwater Heaters

In order to evaluate the fuel saving resulting from the use of feedwater heaters, it is proper to start with an evaluation of the fuel required by a steam turbine power plant when no heaters are used. Figures 2-A, 2-B, and 3, which give the approximate heat rates for turbine-generator sets rated from 500 kilowatts to 7500 kilowatts, may be used for this purpose.

The heat rate[1] defined is:

> The heat rate of any power plant using fuel as a source of energy is the number of heat units which must be supplied for each unit of power produced.

From this definition, it is apparent that the heat rate is an accurate measure of power plant performance. Now, just as there are various definitions of efficiency to represent various concepts, so there are various definitions of heat rate. The overall heat rate applies to the complete power plant and takes into account all losses. The turbine heat rate applies only to the turbine-condenser-feedwater-heater system. The difference between the two is the boiler, auxiliary, and radiation loss. All information on the charts in this article pertains to the turbine heat rate. In the absence of specific data, it may be assumed that with modern equipment, the overall plant heat rate will be in the magnitude of 25 per cent greater than the turbine heat rate. Then, if the cost and heating value of fuel are known, the dollar fuel cost for each unit of power may be easily calculated.

Figures 2-A, 2-B, and 3 thus give an easy way for evaluating fuel costs when feed water heaters are not employed. Figures 2-A and 2-B are the same except that 2-A shows the initial temperature condition expressed in terms of superheat while chart 2-B shows the initial condition expressed as total temperature.

As an example of the use of the turbine heat rate charts, suppose we find the straight condensing heat rate of a 4000 kw. turbine-generator set designed for 600 lb. G.-700 deg. F.T.T. at the throttle, and 2 in. Hg. abs. back pressure, when carrying 3000 kw. load. —Since the total temperature at the throttle is given, Figure 2-B should be used for reading the basic heat rate. At 615 lb. abs., 700 deg. F.T.T., 2 in. Hg. abs., we read a basic heat rate of 14,200 B.t.u. per kw.-hr. From Figure 3, for a 4000 kw. rating operating at 75 per cent of its rated output (3000 kw.), we read a multiplying factor of 0.969. The approximate heat rate of our turbine is, therefore, $14{,}200 \times 0.969 =$ 13,700 B.t.u. per kw.-hr. This value applies when no feedwater heaters are used.

Having obtained the heat rate for operation without feedwater heaters, the next step is to correct this for the addition of any desired number of heaters. This may be done with Figures 4-A, 4-B and 5.

Figures 4-A and 4-B show the percentage fuel saving which could be obtained were it possible to have a 100 per cent efficient turbine operating on a 100 per cent efficient feedwater heating cycle with an infinite number of feedwater heaters. These charts show the maximum possible saving indicated by the steam table without any allowance for losses.

[1]For a complete discussion of heat rate as a measure of turbine performance see: "Modern Turbines, Power Plant Engineering, Nov. 1938."

Of course, in actual practice it will be impossible to realize the full theoretical gain. Feedwater heating cannot be done in an infinite number of steps and, even if this were possible, the fuel saving would not be as great as that shown by the curve because of unavoidable losses. Figure 5 shows what part of the theoretical gain can be realized in practice.

The use of charts, Figs. 4 and 5 may be explained best by continuing with our example of the 400 kw. turbine. Suppose we desire to find the fuel saving which will accrue in this case from the use of two feedwater heaters. First, the theoretical saving should be read from chart 4-A or 4-B. These two charts are the same except that in 4-A the initial temperature condition is expressed as superheat, while in 4-B it is expressed as total temperature. In our case, the initial steam *temperature* is given so we should use chart 4-B. Entering with 615 lb. abs., 700 deg. F.T.T., we read 12.9 per cent as the theoretical maximum gain which could be obtained. From Chart 5, for 2 heaters and 75 per cent load operation, we read 0.60 as the factor of effectiveness for our heaters. The actual fuel saving, then, will be 12.9 per cent $\times$ 0.60 $=$ 7.7 per cent.

With no feedwater heating, the turbine heat rate was found to be 13,700 B.t.u. per kw.-hr. Two stages of feedwater heating will save 7.7 per cent of this amount, or 1050 B.t.u. per kw-hr. Then, the approximate turbine-generator heat rate when operating with the feedwater heaters will be $13{,}700 - 1050 = 12{,}650$ B.t.u. per kw.-hr. Assuming no change of the boiler efficiency, the total fuel saving will be about 25 per cent greater than the 1050, or about 1300 B.t.u. per kw-hr. If this value is multiplied by the yearly kilowatt-hour power output and corrected for the cost and heating value of fuel, the annual dollar fuel saving may be obtained.

Information on Coal Lacking

As a result of a survey of industrial plants, the Bituminous Coal Research, Inc., has revealed the following findings with regard to the selection of coal. 1. Consumers do not have accurate knowledge of coal seams and their burning characteristics; 2. Salesmen do not understand customers specific fuel requirements; 3. Lack of cooperation between buyer and his operating engineer; 4. Lack of knowledge mistaken by both buyer and seller for a breach of honesty; 5. Price rather than suitability dominates coal negotiations; 6. Average firing equipment has serious shortcomings which affect its performance and limit the coal selectivity range; 7. Clinker trouble almost universal; 8. Coal substitution quite prevalent, particularly by jobbers; 9. Present knowledge relating to coal selection and combustion being poorly applied; 10. Size-consists of coal, as delivered, varies widely; 11. Buyers have a fixed opinion that fine coal is synonymous with dirty coal; 12. Coal-handling equipment produces detrimental segregation in many power plants; 13. Coal mixing quite prevalent and detrimental; 14. Inadequate fuel engineering services; and 15. Tremendous turnover in coals.

Starting-Up Boilers

By PULVERIZER PETE

IT IS NOW QUITE some time since I first writes to you, Ed, and by now I have give you lots a lessons on how to make a boiler. If you is nuts you maybe went into the boiler business for a sideline and if you is lucky maybe you sold a boiler. If you has got even more luck you maybe got it erected how I tells you in the August issue of your magazine.

Now you is up to a tough spot. If you was selling fish you could just sling a herring on your customers' porch and maybe if it was not too old (the fish) you would gets paid for it. But when a guy buys a boiler he will probably want it should work and he will want you should make it work. And that means it has gotta make steam until you makes a getaway. Besides he is gonna squawk about effishunsy, draft loss, smoke and probably the color of your eyes. So here is how you goes about it.

The first thing you does is to build a drying out fire. You tells the customer it is for to dry out the refractory, but you really makes a good smoky little wood fire to see how many leaks you got in the setting. You sneaks around and plasters up those you find with something that sticks until you leaves. You should now hope you remembered to connect the boiler to the chimney.

When you has done this you fills the boiler with water and washing soda or cream of tartar or something like that. You then fires up slow and tells the customer you is boiling out the boiler so to clean it inside. Again you is kidding him—you really wants to see if the thing can "take it" before you builds up a pressure (steam, not blood). If you think it won't blow up you drains it and fills it with water. Some guys say use clean treated water, but I says use dirty, oily water. Then you can sell some tubes again pretty quick, which is good business.

Now you is ready for the start-up. First you short-circuits all the fuses and breakers you finds. Then you starts, or tries to start, all the fans, mills pumps, etc., you got around. Maybe you should start a dictaphone too you maybe learns some words from the customer what you want to remember. If no insulation on the wires melts and nothin' is wrecked yet you has done a good erection job.

One trouble you probably gets before you gets any steam up is fan blades rubbing on the casing. Here is a trick which is much more quick than lining up the fan again. You just takes a cutting torch and cuts about an inch off the blades which is rubbing.

Now, no doubt your steam temperature is cock-eyed. If it is high you is ok because when you designs the superheater you don't know how to design a superheater so you puts in twice as many elements as you thinks you needs. So now you takes out some. You can just weld a plug in the end through the hand hole. The rest of the tube soon will disappear. Probably you has took out too many and now the temperature is too cold. But you don't got to worry. You just hammers some dents in the outlet ends of the tubes. This makes the steam go through slower and have more time to get hotter quicker.

Probably your capacity is too low. You does one of a coupla tricks. You gets new charts for the meter so they read what you want to get but don't or you bends the pen arm so it points where it should oughta after what you tells the customer when you peddles the pot.

You thinks you is all set but your customer he changes your mind. He says your effishunsy is low. You says you figures you is working pretty quick but

You sneaks around and plasters up the leaks

he gets sore and says he means the boiler. You tell him you will fix it and here is what you does. You empties his coal bin and fills it with coal which has got more B.t.u. Then you runs a new test and beats it before he starts gettin' down to his coal again.

If he crabs about unburned carbon tell him you told him he should oughta burn gas anyway. That should answer him also if he kicks about slagging tubes but elsewise you could tell him to chromiumplate them which makes them so slippery no slag would stick—maybe.

Another beef would be about flame impingement. This perhaps means you gotta fiddle with the burners but if you got thick walls in the furnace you can chisel them thinner until the flame don't hit them no more.

High draft loss is a problem you gotta work out yourself, Ed, because my pencil is getting dull. I got one idea which maybe you can try and that is build a bypass duct from the furnace to the chimney.

I now feels I knows you pretty good, Ed, so I guess I will lets you in on a secret which is I once has a big job on a tanker which was to keep rust off the Diesel engine. So perhaps soon I will tell you how I keeps the Diesel Dieseling.

Tri-County Electric Cooperative

Two 346 kw. Diesel generating sets operate in parallel with two hydro units to give a total capacity of 950 kw., serving new rural district around Eaton Rapids, Mich. Over 500 miles of transmission and distribution lines in service and 1000 more under construction.

JUST OUTSIDE of Eaton Rapids, Mich., a new generating station with two 346 kw. Diesel units, has been completed to serve the Tri-County Electric Cooperative, organized with the assistance of the REA. The new Diesel plant, built with money borrowed from the REA is really an extension to a hydro plant constructed on the Grand River about 2 yr. ago by the Miller Dairy Farms. This firm will operate the two hydro and the two Diesel units in parallel and sell power to the cooperative. About 500 mi. of transmission and distribution lines have already been built in Eaton, Ingham, Iowa, Clinton and Barry Counties. Eventually the system will be extended by another 1000 mi. and a substation adjacent to the present power plant building.

Each of the two engines is a 500 hp., 360 r.p.m. Worthington type D 5-6 with a Woodward governor, Alnor pyrometer, Manzel 12 pt. lubricator, Cuno oil filter, Ross oil cooler and Minneapolis Honeywell Pressurestats and Aquastats. Each engine drives an Elliott 432.5 kv.-a., 0.8 p.f. 2400 v., 3 ph., 60 cycle generator and a 10 kw. direct connected exciter.

Electrical control is centered in a 6 panel Powerlite switchboard made up of two generators, a voltage regulator, two feeders and an auxiliary panel, the latter incorporating Rees push button control for all motor driven auxiliaries. Auxiliary power is taken from three G.E. 15 kv.-a. single phase 2400/240 v. transformers. A Ward-Leonard electronic voltage regulator for each unit is installed and Sangamo watthour meters are provided for each generator, each feeder and the auxiliary panels. In addition an Easterline-Angus instrument records the plant load and voltage. Indicating voltmeters, ammeters, frequency meters and power factor meters were supplied by Weston and the oil circuit breakers by Allis-Chalmers.

Fig. 1. Auxiliaries are grouped at one end of the plant. This view shows, from left to right, the vertical heater exchanger, the cooling water pumps, water softener, clean oil tank and oil purifier

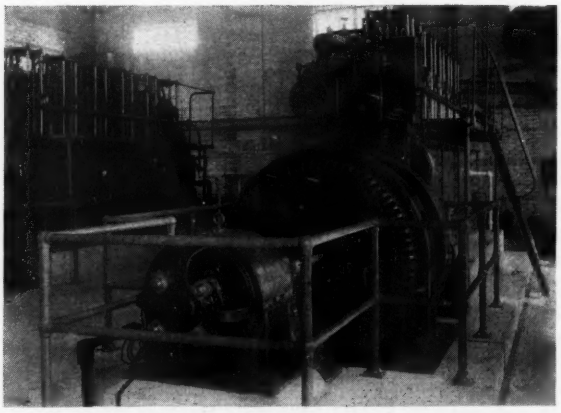


Fig. 2. Two 500 h.p. Worthington Diesel engines are installed, each driving an Elliott 432.5 kv.-a. 0.8 p.f., 2400 v. generator and direct connected exciter

The plant arrangement, shown by the plan and cross section Fig. 3, is simple but well adapted to small plant needs. There is no basement and the auxiliaries are all grouped at one end of the station. All fuel is received by truck and stored in two 20,000 gal. underground tanks. From there it is pumped as needed by two fuel transfer pumps located in one corner of the station and discharging through a Skinner filter to two 250 gal. day tanks immediately above. Both of these pumps are Worthington centrifugals, each driven by a ½-hp. Westinghouse motor. Overflow from the day tanks is caught by a 50 gal. tank just below the floor level. Oil to the engines is metered by Worthington disc type oil meters and fuel oil day tank level is indicated by Detroit Lubricator Co. gages installed in the engine room near the transfer pumps.

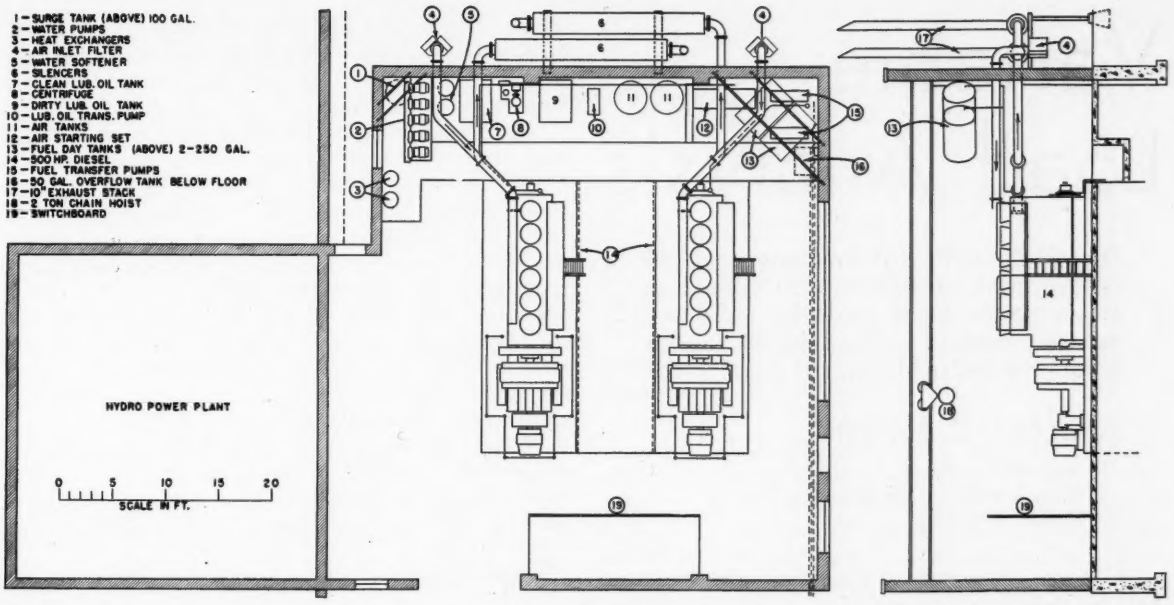

1 – SURGE TANK (ABOVE) 100 GAL.
2 – WATER PUMPS
3 – HEAT EXCHANGERS
4 – AIR INLET FILTER
5 – WATER SOFTENER
6 – SILENCERS
7 – CLEAN LUB. OIL TANK
8 – CENTRIFUGE
9 – DIRTY LUB. OIL TANK
10 – LUB. OIL TRANS. PUMP
11 – AIR TANKS
12 – AIR STARTING SET
13 – FUEL DAY TANKS (ABOVE) 2–250 GAL.
14 – 500 HP. DIESEL
15 – FUEL TRANSFER PUMPS
16 – 50 GAL. OVERFLOW TANK BELOW FLOOR
17 – 10" EXHAUST STACK
18 – 2 TON CHAIN HOIST
19 – SWITCHBOARD
HYDRO POWER PLANT
0 5 10 15 20
SCALE IN FT.

Fig. 3. Plan and cross section of the station. The two water wheels installed about two years ago by the Miller Dairy Farms, and totaling 250 kw., are in a room adjacent to the Diesel plant

In the opposite corner are five Worthington 2½-in. Type D Monobloc pumps driven by 5 hp. Master motors. Two of these take raw water from the hydro plant forebay and pump through the Ross vertical heat exchangers. Two of the pumps are on the soft water system for engine cooling and the fifth unit is piped up as a spare so that it can be used on either the raw or soft water system. The soft water system is provided with a 100 gal. overhead surge tank and makeup is provided through a Permutit zeolite softener.

Lubricating oil cleaning facilities consist of a clean and dirty oil tank with a Skinner Purifier unit set between them. The system is piped up so that a single Viking transfer pump, driven by a 1/6 hp. Leland motor handles oil both to and from the engines. Next to the lubricating oil station is the starting air equipment with two air receivers and a Worthington 2 stage air cooled V type air compressor. This machine can be driven, through a Multi-V-Drive, by either a 5 hp., 240 v., G.E. 1735 r.p.m. motor or a Novo 5 hp. 3⅜ by 4 in. single cylinder gasoline engine. Crane valves and piping were used throughout and both engines are served by a 2 t. Hercules chain hoist.

Air intakes, each with two American Air filter units, are installed outside against the rear wall of the building, and the arrangement of the intake, exhaust and water lines is well shown by Figs. 2 and 3. The engine exhaust line, with expansion strains taken up by a short length of corrugated copper pipe, extends horizontally through the rear wall to Maxim silencers on the outside. The two silencers placed horizontally, both in the same plane, are supported on 6 in. 8.2 lb. channels, one end of which is embedded in the brick wall and the other supported on 4 in. pipe as shown by the drawing. 10 in. exhaust stack discharges the gasses to about 4 ft. above the roof level.

The building itself is of brick construction with about half the area of the south wall taken up by metal sash windows. Doors to the outside are provided in the east, south and west walls and the north side opens into the hydro plant. The interior dimensions are 44 by 46 ft. 8 in., with a height to the crane rail of 16 ft. 4 in. Allowing for the jog in the northeast corner, this gives a total floor area of 1963 sq. ft. and a volume of 32,000 cu. ft., or on a unit basis, 2.8 sq. ft. and 45.7 ft. per kw. of capacity.

Consulting engineers were the Southern Michigan Eng. Corp. of Lansing, Mich. William V. Clegg is manager of the Tri-County Electric Cooperative and D. R. Cady is chief engineer of the plant.

TO PROTECT those workmen whose skins may become irritated or infected by dirt or other foreign matter, American Optical Co. suggests the goggles be thoroughly cleaned or sterilized at stated intervals. They recommend the following methods: 1. Wash the goggles in a hot solution of soap and water. Scrub the eyecups, lens rings and side screens with a stiff brush. If the goggles are spotted with paint or tar a ten minute soaking in a solution of varsol will clean the surfaces. Next, soak the goggles for 30 min. in a 3 per cent cresol solution. Then they should be hung on a support to dry. 2. Wash the goggles in a hot solution of alcoholic green soap, rinse in warm water and hang to dry. 3. Simply immersing the goggles in boiling water for 5 min. has been found to accomplish sterilization satisfactorily. 4. Soaking for 10 min. in a solution of formalin made by placing one part of 40 per cent formaldehyde solution in nine parts of water is another simple and practical method. 5. Scour the goggles to remove all dirt and then submit them to a 5 min. exposure of ultra-violet light. This is usually done in the first aid room or emergency hospital of the company where equipment for doing it is maintained. 6. Another method is subjection to sterilization by a moist atmosphere of antiseptic gas, preferably formaldehyde, for a period of 10 min. at room temperature.

Variable Load Analysis

Predetermination of fuel necessary for carrying a given variable load by a Diesel or steam station easily made by rapid and accurate method outlined by the author before the Dallas Meeting of the A.S.M.E.

By GLENN C. BOYER

Associate Engineer,
Burns & McDonald Engineering Co.,
Kansas City, Mo.

ENGINEERING STUDIES of steam-and Diesel-driven electric generating plants have shown the need of a rapid method for obtaining the average performance of a contemplated installation over a variable yearly load cycle. In speaking of the performance of a particular generating station we constantly refer to "B.t.u. per kw-hr. generated" when discussing steam prime movers or "kw-hr. per gal. of fuel oil" for Diesel prime movers. After the station is in operation, these figures are readily obtainable from the plant performance record. It is only when we attempt to predetermine this information for a proposed installation operating under known or assumed conditions that difficulties appear.

These difficulties result from the fact that the load served by an electric-generating plant varies. The maximum load carried by a plant may range from four to six times the minimum load during the period of one year. Recent studies of a midwestern generating plant having a 60 per cent annual load factor, showed a ratio of 4 to 1 from maximum to minimum load. The load factor of the plant appears to bear no relation to the spread between maximum and minimum load on the plant.

In another instance the maximum load on a small generating plant was 1050 kw. and the minimum load 175 kw., a ratio of 6 to 1 from maximum to minimum load. During this same year the plant produced a total of 3,854,400 kw-hr. and the annual load factor was 41.9 per cent. It was desired to make certain improvements in generating equipment in this plant operating with steam prime movers at 175 lb. per sq. in. gage pressure, and it became necessary, therefore, to estimate accurately the performance of contemplated equipment in order to make a comparison with present performance.

When discussing load variation in a generating station, the tendency has been to attempt to show load variation by means of daily load curves. Figure 1 contains two daily load curves for this plant for the maximum and the minimum day during one year. While these load curves show what happened throughout the 24 hr. of two specific days, they can never give a complete picture of the load variation which that plant was called upon to furnish throughout the year. In order to present the complete story of load variation, it will require not two but 365 daily load curves. Should the attempt be made to plot all 365 curves on Fig. 1, they would interlace to the point of being meaningless.

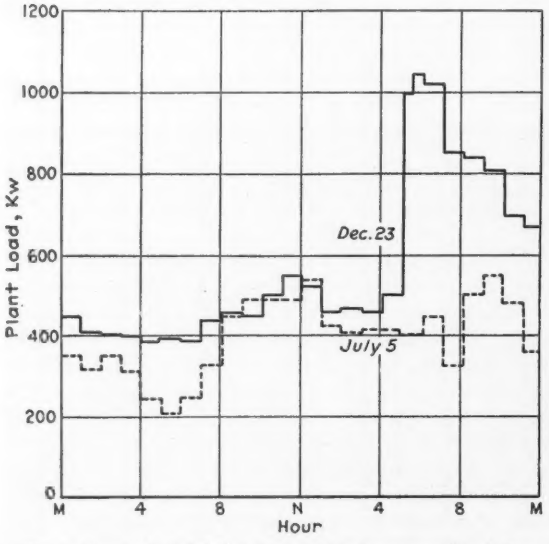


Fig. 1. Two typical daily load curves showing seasonal variation

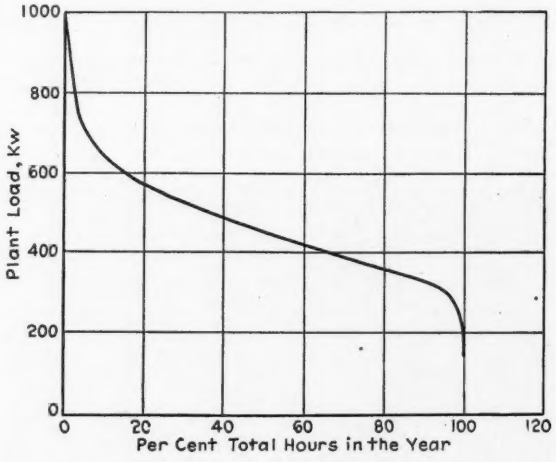


Fig. 2. A load duration curve is the best method of representing load variations for a given period of time

The first necessity, therefore, is a means for presenting the load variation for a total of 8760 hr. or 1 yr. in such a manner that the data will be of value. The load-duration curve, Fig. 2, is the best-known means for presenting the variation in load for any period of time in a manner that lends itself to ready interpretation. As plotted in Fig. 2, any point on this curve shows the per cent of the total hours in the year when the load exceeded a given value. Thus, while the peak load on the plant was 1050 kw., the load exceeded 575 kw. 20 per cent of the time, and 450 kw. 50 per cent of the time.

It should be pointed out in passing, however, that

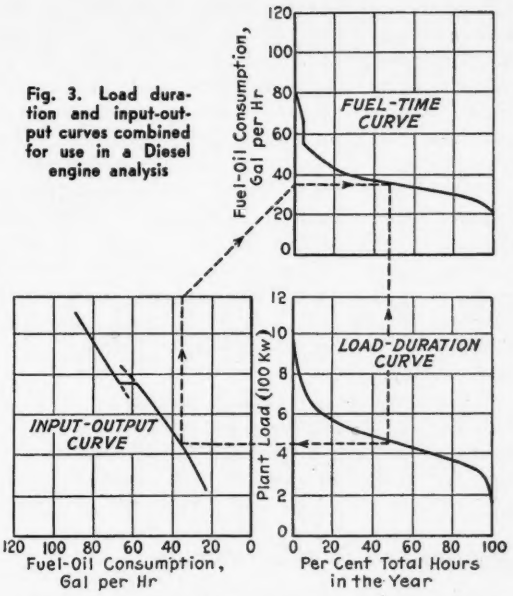


Fig. 3. Load duration and input-output curves combined for use in a Diesel engine analysis

since the abscissa or horizontal axis of the duration curve, Fig. 2, represents time and the ordinate or vertical axis represents load, the area under the curve represents power output. This property of the curve will be referred to in greater detail later. The load-duration curve can also be employed as a graphical representation of annual load factor, since the ratio of the area under the duration curve to the area of the rectangle bounded by the X and Y axes, the abscissa for the maximum load on the plant and the ordinate for 100 per cent total hours in the year is annual load factor.

In the consideration of an improvement program for a electric-generating plant as previously referred to, it is desirable to know the kilowatt hours generated per gallon of fuel oil during a year's period if Diesel prime movers were used in place of steam turbines. The load duration curve in Fig. 2 was derived from the operating data for this plant and will be employed in the analytical method presented in this paper. In addition to the load-duration curve the guaranteed performance data for the Diesel-engine unit or group of units under consideration is also necessary.

For this particular plant, one of the plans under consideration utilized two Diesel-engine generating units each having a full-load capacity of 870 kw. The operating schedule called for the second unit to be started when the plant load reached 750 kw. and the plant load above this value was to be divided equally between the two machines. With this operating schedule and the fuel guarantees of the units under consideration, a curve of engine performance can be plotted with plant load in kilowatts as the ordinate and gallons of fuel oil per hour as the abscissa.

In the lower right-hand corner of Fig. 3 is reproduced the load-duration curve from Fig. 2, and in the lower left-hand corner of Fig. 3 is plotted the performance or input-output curve for the group of generating units considered. In plotting the load-duration curve the abscissa values increase in the right-hand direction from the origin, while in the case of the input-output curve the abscissa values increase in the left-hand direction from the origin. The values for the ordinates are common to both curves.

With the use of these two curves and elementary mechanical projection, a third or fuel time is developed in the upper right-hand corner in which the abscissa is per cent total hours and the ordinate is gallons of fuel oil per hour. The mechanics of the development of the fuel-time curve is shown by means of the dashed lines and arrows for locating one point on the curve. Fundamentally, this curve shows the per cent of time during which the rate of burning fuel oil exceeded a certain number of gallons per hour. Since the abscissa of this fuel-time curve is time and the ordinate rate of oil consumption, the area under the curve is proportional to the quantity of fuel oil consumed in generating the quantity of electrical

Table I. Summary of Diesel Plant Analysis

Total energy generated (actual), kwhr	3,854,400
Total energy generated (area under curve), kwhr	4,150,000
Per cent error	7.5
Total fuel oil consumed (area under curve), gal	351,000
Kilowatthours generated per gallon oil $= \frac{4,150,000}{351,000} =$	11.85
Btu per kwhr generated	11,800
Over-all plant efficiency, per cent	29

Table II. Summary of Steam Plant Analysis

Total energy generated (actual), kwhr	3,854,000
Total energy generated (area under curve), kwhr	4,150,000
Per cent error	7.5
Total steam required (area under curve), lb	55,950,000
Total coal 9000 Btu per lb (area under curve)	10,510,000
Pounds steam per kwhr generated	13.5
Pounds coal per kwhr generated	2.54
Btu per kwhr generated	22,800
Plant thermal efficiency, per cent	15
Rate of steam production, maximum, lb per hr	11,750
Rate of steam production, minimum, lb per hr	4,000
Rate of coal consumption, maximum, lb per hr	2,100
Rate of coal consumption, minimum, lb per hr	875

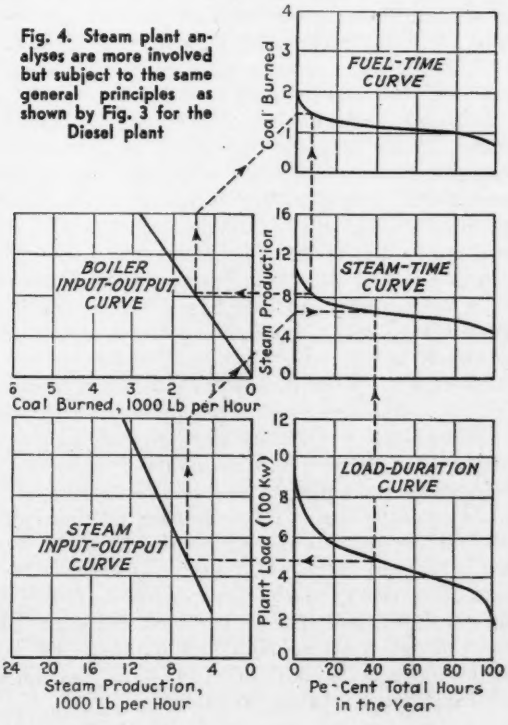


Fig. 4. Steam plant analyses are more involved but subject to the same general principles as shown by Fig. 3 for the Diesel plant

energy represented by the area under the load-duration curve. This proportion is readily obtained. If, for example, one inch horizontally represents 20 per cent of the total hours in the year or 1752, and one inch vertically represents 10 gal. of fuel oil per hr., then 1 sq. in. of area under the fuel-time curve represents 17,520 gal. of fuel oil consumed.

For office use the three curves on Fig. 3 are plotted on a sheet of cross-section paper approximately 17 in. by 20 in. Since standard cross-section paper divided 10 by 10 to the inch is available in rolls 20 in. wide, no difficulty is experienced in obtaining sheets of practically any dimensions for developing the curves.

Areas under the load-duration and fuel-time curves can be obtained either by the use of a planimeter or by counting squares. From curves developed in connection with this analysis for Diesel-egine generating units, the information in Table I was obtained.

It is seen from Table I that an error of 7.5 per cent is introduced in development of and determination of the area under the load-duration curve. For analytical purposes, all calculations are based upon the areas found under the various curves, due to the fact that an error introduced into the load-duration curve is automatically reflected in the fuel-time curve. By using the values determined from the curves, the per cent error in the figure for kw-hr. generated and the value for the total fuel oil consumed as determined from the fuel-time curve are employed. By using the latter combination of values a 7.5 per cent error is automatically introduced into the value for the quantity of fuel oil consumed, without any compensating error in the quantity for total generation in kw-hr.

The input-output curves for contemplated improvements employing other sizes of generating units could be plotted on the lower lefthand portion of Fig. 3, and their respective fuel-time curves developed. These would enable the designing engineer to readily select the most economical combination of units from the fuel-economy standpoint.

Although somewhat more involved, the same procedure can be used for the study of contemplated steam-plant improvements. With the load-duration curve in Fig. 2 and the heat-balance calculations for a proposed steam cycle utilizing a 2000-kw. turbine operating at 400 lb. per sq. in. ga., 750 deg. F. total temperature and a 28 in. vacuum, the basic information is available for starting Fig. 4. As in Fig. 3, the load-duration curve, Fig. 2, is plotted in the lower right-hand corner and the input-output curve for the steam cycle is plotted in the lower left-hand corner. The steam-time curve is then developed by means of mechanical projection immediately above the load-duration curve. It is necessary to consider the efficiency of the boiler to know the quantity of fuel which would be burned. By plotting an input-output curve for the boiler to the immediate left of the steam-time curve and above the input-output curve of the steam cycle and by mechanical projection, a fuel-time curve is developed. The boiler input-output is based upon the use of bituminous coal running 9000 B.t.u. per lb. and a boiler with 4000 sq. ft. of heating surface exclusive of the superheater.

The three curves to the right of the major vertical axis consisting of the load-duration curve, based upon actual operating data, and the steam-time and fuel-time curves which were developed mechanically, afford a complete picture of the operation of the proposed plant under known load conditions. From them can be obtained the following information: (a) Total kw-hr. generated as well as maximum and minimum station loads in kilowatt. (b) Total steam produced by the boilers as well as maximum and minimum rates of steam production. (c) Total coal burned as well as maximum and minimum rates of burning.

From the curves developed in Fig. 4, Table II was formulated.

When applied to existing equipment in a small steam-generating station the results in terms of pounds of coal per kw-hr. generated obtained by the foregoing analytical method have checked within a range of 7 to 10 per cent of actual coal consumption.

Cylinder and Ring Scratching

THE PROBLEM of cylinder and ring scratching is receiving considerable investigation. Briefly, there are three important factors involved in this problem, namely, metallurgy, lubricating oils, and breaking-in methods. Because of the tendency of certain combinations of ring and liner materials to exhibit what might be termed incipient scratching proclivities, there is need for lubricants of high load-carrying ability. Operating conditions often made it difficult to support suitable oil films. Quite recently considerable progress has been made in the development of additives which exhibit superior load-carrying ability, even under the most adverse conditions for film formation and support.

The manner in which raw machined surfaces are transformed into bearing surfaces capable of maintaining an oil film is of considerable importance in relation to the ultimate life of the liner and rings. It has been found that certain methods of break-in endow reciprocating surfaces with wear resistance which continues its influence after thousands of hours. Additives used to shorten break-in periods have had the effect of reducing the wear during many thousands of hours of operation. In other words, the influence of the chemical additives even though used for only a short period lasts throughout the life of the reciprocating rubbing surfaces.

Quite recently material improvements have been made in providing rapid and safe break-in by the use of chemical treatments on the cylinder and ring surfaces. The purpose of these chemicals is to endow the reciprocating faces with extreme-pressure characteristics and encourage the rapid spreading of the lubricant during the break-in period. By transforming the cylinder surface to a blotter-like material, the lubricant is absorbed quickly and adheres tenaciously, thus permitting a rapid form of mild abrasion which produces superior wearing surfaces. By this process piston rings which normally required about 100 hr. to obtain full ring-face conditioning and 100 per cent bearing face can be run in to comparable surface contacts in 3 hr.—Rosen before the A.S.M.E.

Part XXXII

In cases where a moderate amount of direct current power is needed, the phanotron rectifier has proved useful and economical. In this article the application of such rectifiers to elevator service is described but they are equally adaptable to other services. Where loads of 50 to 75 kw. are concerned these units have definite advantages over other types of conversion equipment.

ELECTRON TUBES— Principles and Applications

By A. W. KRAMER

THE DEVELOPMENT of large power tubes for equipments such as the thyratron excited synchronous condenser described in the preceding installment of this series, naturally leads to other applications of a similar nature where moderate amounts of direct current power are required. In such instances the electron tube equipment merely takes the place of the usual rotating converters or motor generator sets. For certain purposes such electron tube equipments have many advantages over other forms of converters.

In the case of the electron tube exciter already described, the equipment was complicated by the requirement that the direct current output not only had to be sufficient to meet the maximum excitation requirements but that it had to be regulated in accordance with changes in the a.c. line voltage; hence it was necessary to use thyratrons; that is, grid controlled gas-filled rectifiers.

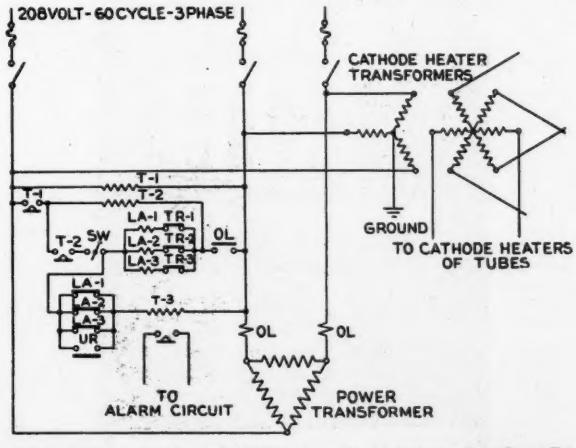


Fig. 1. The A.C. Control Circuit for the Phanotron Rectifier. T-1 Cathode Heater Timing Relay. T-2 Reclosing Timing Relay. T-3 Alarm Relay Circuit. LA 1, 2, 3, Thermal Relays. TR 1, 2, 3, Thermal Relays. OL Overload Relay. SW Control Switch. UR Unbalance Relay

Where the problem of voltage regulation does not enter, the equipment is simpler and the ordinary two electrode gas-filled tube can be used. These are usually called phanotrons.

As pointed out in a recent paper presented before the A. I. E. E.[1] in applications where some form of conversion equipment is to be used, a phanotron rectifier possesses many advantages. Its first cost is competitive with other forms of converters. It has no rotating parts and so requires no special foundations. It is quiet in operation and is more efficient than a motor generator set.

The use of such rectifiers in elevator power supply systems is of particular interest, as it is the first industrial application of the modern metal electron tube in power sizes. In addition, the automatic features incorporated in these rectifiers have resulted in a very successful service record and consequently merit the attention of those interested in applying electronic equipment for power purposes.

These rectifiers for elevator service have proved particularly useful in cities where public utility companies are engaged in curtailing and in some cases completely eliminating the d.c. power supply to concentrated load areas. The change from d.c. to a.c. for elevators in such affected areas either requires the substitution of a.c. elevator equipment or the use of converters to supply direct current to the existing direct current elevator motors.

As described in the A. I. E. E. paper referred to above, a trial installation of an electron tube rectifier for such an elevator power supply was made in Chicago in 1935. This was a four-tube rectifier operating from a power supply of 208 v., 3 phase, 60 cycles, and

[1] Phanotron Rectifiers as Direct Current Supply for Elevator Motors. By C. C. Clymer and R. G. Lorraine. Presented at the winter meeting if the A. I. E. E. in New York, Jan. 1938.

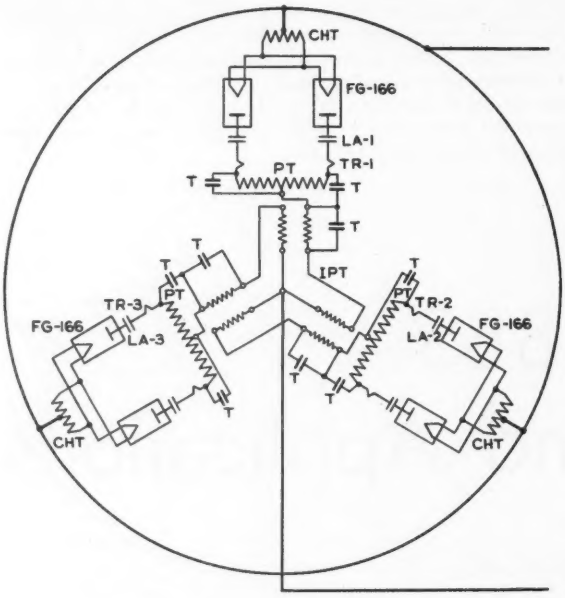


Fig. 2. Elementary Diagram of the Power Circuit CHT Cathode Heater Transformer. IPT Interphase Transformers. LA 1, 2, 3 Anode Contactors. FG-166 Phanotron Tube. PT Power Transformers. T Thyrite Arrestors. TR 1, 2, 3 Thermal Relays

delivering direct current at 230 v. Later on, a modified design using six phanotron tubes was built and this operated so successfully that all subsequent rectifiers for elevators have followed this same fundamental design. A number of these units are now in service, these units ranging from 25 kw. at 1 hr. to 40 kw. continuously at 230 v., and 50 kw. at 1 hr. 550 v.

The power and control circuits for an installation of this kind are shown in Figs. 1 and 2. As will be noted, the tubes are connected in what is called a triple single-phase full wave circuit, each tube carrying the current for 180 electrical degrees. The tube used in these installations has an average rating of 30 amperes with a peak rating of 150 amperes. Thus, such a single full-wave rectifier would have an average current rating of 60 amperes and a maximum momentary peak rating of 150 amperes. Likewise, three such rectifiers, one connected to each phase of a three-phase supply, as shown in the circuit diagram and having their cathodes paralleled through interphase transformers, will have a combined rating of 180 amperes, and a momentary peak rating of 450 amperes. This so-called triple single-phase full-wave circuit has the additional advantage of balancing the load on the three-phase supply.

In interpreting the two diagrams Figs. 1 and 2 it must be understood that on the control diagram only the primaries of the power transformer are shown, and that on the power circuit diagram, only the secondaries of the power transformer are shown.

Transformers operating in rectifier circuits are subjected to transients during faulty operation. To protect the windings against any surge voltages that may be induced at such times, thyrite resistors are connected across the power transformer secondaries to neutral, and across one winding of each interphase transformer.

Except for the method of connection and the elements of the control circuit, there is of course nothing fundamentally unique about this application of the electron tube. It is simply a rectifier and its only purpose is to supply a reasonably smooth direct current of suitable magnitude from an alternating current input. In that respect it is as simple as a Tungar or Rectigon battery charger.

But as in all cases of electron tube development involving power there are many obstacles between the conception of an idea and its actual practical application, and these had to be overcome. The all metal thyratron tube itself had to be developed. The control circuit also had to be developed. This control circuit presents no electronic problem, it consists merely of suitable relays and switches to protect the tubes in case of arc backs or other trouble. In case a tube arcs back, the overload relay OL opens the coil circuit to the contactors, which immediately open. After two seconds the anode contactors are reclosed by the reclosing relay T2. If the trouble persists after several reclosures, one of the three double-pole temperature overload relays TR 1-2-3 in the faulty circuit will open the coil circuit of its associated anode contactor and operation will be continued with the remaining phases of the four tubes. The tubes are removed in pairs because the failure of one tube in a single phase full wave circuit produces saturation in its anode transformer and also reduces the average output voltage resulting in the remaining tubes carrying practically no current.

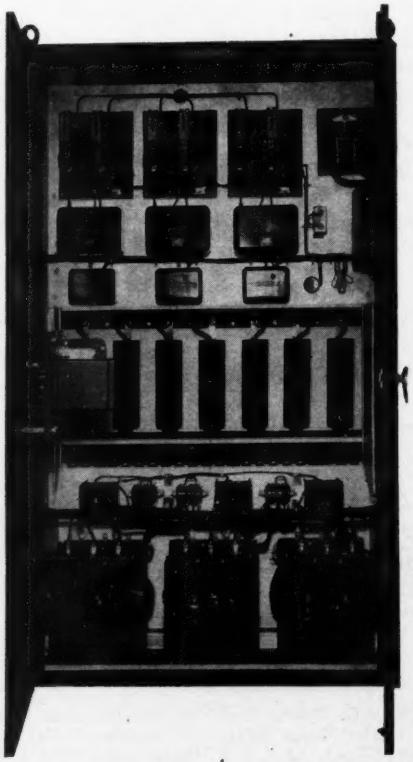


Fig. 3. Front view of rectifier with main door and tube compartment door open

The opening of the contactor in one single-phase circuit changes the ripple frequency causing the operation of the unbalanced relay UR. The operating coil of this relay forms a part of a series tuned circuit connected across the d.c. output, as shown in Fig. 4. If the tube fails to conduct due to lack of emission, the unbalanced relay UR will operate an alarm, no

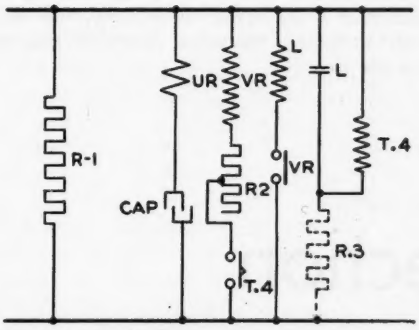


Fig. 4. The D.C. Control Diagram. R1 Loading Resistor. UR Unbalance Relay. CAP Capacitor. VR Voltage Relay. R-2 Variable Resistor. T-4 Timing Relay. L Contactor. R-3 Regenerative Loading Resistor

other relays operating. In order that a spare tube may be placed in operation, provision is made for holding it between the active tubes so that the radiated heat will keep it warm and the mercury properly distributed.

In connecting the rectifier to the a.c. source of supply, the cathode heating transformers CHT (Figs. 1 and 2) are energized and excitation supplied to the tubes. A tuning relay T1 is energized and after a predetermined time voltage is applied to a reclosing timer T2. In two seconds, voltage is applied to the closing coils LA-1, 2 and 3 of the three tube anode contactors, provided the control switch SW is closed. The closing of these contactors completes the circuit and makes the power available.

In this particular application to elevator operation, it is necessary to provide a means for regenerative breaking. In ordinary elevator practice, when the elevator is lowering a sufficiently heavy load, it holds speed by regenerative breaking, i.e. the motors act as generators and tend to feed current back into the line. The rectifier, however, cannot return power back into the supply circuit, hence it is necessary to provide a loading resistor in the d.c. circuit which can be cut into the circuit when this "reverse" power appears. This loading resistor is shown as R_3 in Fig. 4. Normally, it is out of the circuit, but when the voltage on the d.c. bus rises sufficiently above no-load voltage to actuate the voltage relay VR, which in turn closes the loading resistor contactor L and allows the resistor to absorb the overhauling load.

This application of phanotron rectifiers to elevator motor installations has been described in detail because it is one of the first general applications of large electron tubes for power purposes. Fundamentally, as has already been pointed out, there is nothing unique about the idea, but it provides a simple, efficient method of obtaining an adequate supply of direct current from an alternating current source.

Units of this kind have been applied not only to elevators but to other purposes as well. In one case an installation was made in a machine shop for supplying direct current power to cranes. In another case one of these units handled an entire building load, elevators, fans, pumps, etc.

These units can be installed in out of the way corners, locked in cubicles if desired, and they will operate without attendance. So far they have been made only in units of moderate capacity, up to around 75 kw. at 550 v. Undoubtedly they will be made larger. However, where large amounts of power are needed and where rectifiers are desired, the mercury arc type described in an earlier chapter[2] are available in sizes of 750 kw. or more.

This method of supplying power to motors through electron tubes must not be confused with various systems of electron tube motor control which have been worked out. Where speed control is necessary three element or thyratron tubes are used. A notable installation of this kind was made in the Logan Station of the Appalachian Electric Power Co. in 1936, where

Fig. 5. FG-166 Hot Cathode Tube Used in Rectifiers

a 400 hp. thyratron controlled motor was installed to drive a large induced draft fan. This installation has been completely described elsewhere,[3] but since that time various other systems of electronic speed control have been worked out and these will be described in subsequent articles of this series. Some of these systems are still more or less in the experimental stage, but enough work has been done on them to indicate their possibilities. The idea of a simple system of control for a.c. motors that would give smooth speed control over a wide range has long been the dream of electrical engineers and it is possible that the realization of this dream may lie in some form of electronic control; indeed, the thyratron motor at the Logan Plant is a long step toward its solution.

[2] Part XX, p. 606, October 1937.

[3] Power Plant Engineering, March 1938, p. 188.

Few things so intrigue the imagination as does the power to photograph through solid steel by means of the X-ray. To the layman this power is even more of a mystery than radio which he has come to take for granted. Technical men, generally, understand the process and are beginning to use it more and more as a tool to extend their field of action, but specific knowledge regarding the practical aspects of X-ray inspection is still quite vague. It is for this reason that we are glad to be able to present an article dealing with the actual practice of X-ray inspection in a way that will be of direct benefit to those in the power plant field who may find occasion to use it.

Radiographic Inspection in the Power Plant

By HERBERT R. ISENBURGER
St. John X-ray Service, Inc.
Long Island City, N. Y.

IN RADIOGRAPHIC EXAMINATION shadow pictures are obtained showing the interior condition of the object under investigation. These pictures are made by means of a penetrating radiation of either x-rays, produced electrically by an x-ray tube, or by gamma-rays, which are of shorter wave-length than x-rays[1] and are obtained from radium, mesothorium, or their emanations. X-ray pictures have been called originally by the writer "exographs" and are known as such today as distinguished from gammagraphs made by means of gamma-rays. As with ordinary photographs, darker regions on the negative or lighter regions on the print mean that more rays have passed through the object at that point, indicating that the object is more transparent at these points. Hence cavities in a weld will show up on the print as lighter spots, whereas denser metal will appear as darker regions.

Absorption of the rays grows with the atomic weight of the material examined. When x-rays are used, absorption is almost proportional to the third power of the atomic number of the element[2]. On account of its high atomic weight, lead is used to protect the operator, since sufficient thicknesses of lead will absorb the x-rays completely[3]; on the other hand, about 1 per cent of gamma-rays will penetrate even through 2 in. of lead (570)[4]. The serious dangers involved in continuous handling of radium cannot be mentioned often enough and whenever possible this material should not be employed. The largest user of radium for industrial purposes is the Navy Department. This is due to the fact that materials used in Naval construction are frequently thicker

[1] The average wave-length of x-rays is about 1/10,000 that of ordinary light, and 1,200,000 volts would be required to obtain x-rays with a wave-length equal to the average gamma-radiation from radium.

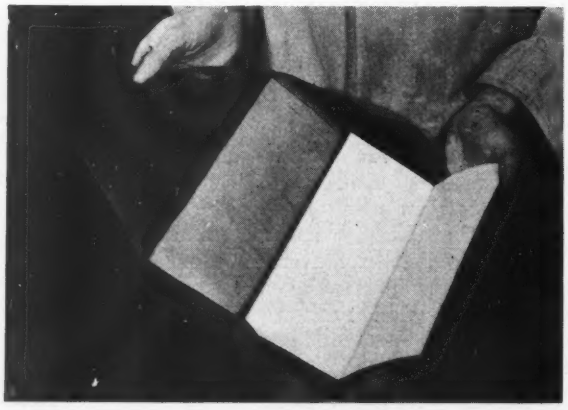


Fig. 1. St. John folding film holder

[2] The 92 Elements. St. John X-Ray Serv., Long Island City, N. Y.

[3] St. John & Isenburger, Industrial Radiography. John Wiley & Sons, New York. Tables III and IV., 1934.

[4] This and the following numbers refer to references given in H. R. Isenburger, Bibliography on Industrial Radiography. Doc. 1139. American Documentation Institute, 2101 Constitution Ave., Washington, D. C., 1938.

than x-ray inspection would permit economically. Navy engineers, however, know the limitations and state that "up to thicknesses of two inches the x-ray method is more sensitive, and requires much less time"[5]. Since we are dealing with materials in power plant construction which seldom exceed 3 in. of steel and since we have x-ray apparatus which can handle such thickness in one-minute exposures, we do not have to consider gamma-ray examination in our further discussion.

One of the most important tools in radiographic inspection is the "camera". This is a film holder, containing a pair of intensifying screens which speed up the exposure considerably. X-ray film is coated on both sides so that the reaction is doubled. Intensifying screens are made of calciumtungstate, a chemical which converts x-rays into light rays to which the film emulsion is much more sensitive than to x-rays. These film holders or cassettes can be made of metal for standard sizes or can be made up readily of cardboard as the one developed by the writer and illustrated in Fig. 1. This is particularly convenient for odd sizes or when a great number of film holders speed up routine inspection work since these folding holders are inexpensive and light in weight. It is important that perfect contact between the screens and the film is maintained. For this purpose the flexible holder is tied between two Bakelite sheets and placed on one side of the object under examination as illustrated in the case of a cast Tee fitting in Fig. 2. On the opposite side of the object is the x-ray tube.

The design and construction of the x-ray tube is the most important feature in an x-ray installation. Manufacturers are continuously improving their products and yet it is still the weakest link in the installation. Tubes have to be handled with great care and should be treated exactly as specified by the manufacturer. A new and most suitable tube for industrial radiography has recently been put on the American

[5] Welding Handbook. A.W.S., 1938, p. 772.

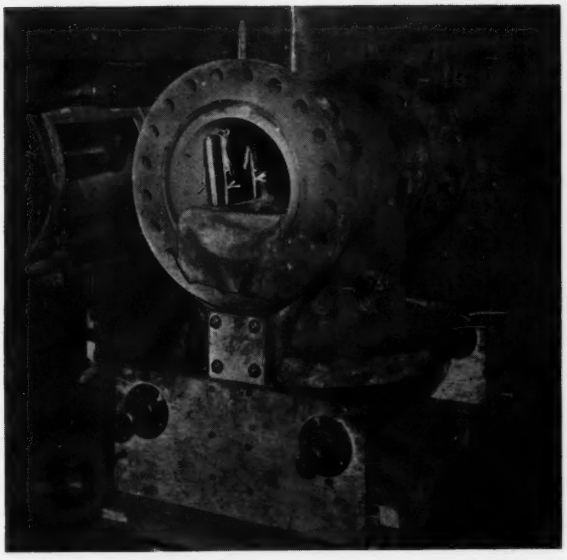


Fig. 2. "X-Ray Camera" set up for inspection of a portion of a cast Tee fitting

market and has been described in detail elsewhere (760). The special features of this tube make fast and efficient work possible. For quick reference, exposure conditions can be read off from specially developed charts as illustrated in Fig. 3. They have been established at a 16-in. focus-film distance. Correct exposure times for greater or smaller distances can be found by multiplying the 16-in. distance time by the amount of minutes found opposite the distance figure on the scale at the left-hand side of the charts. The basic steel density was taken as 7.6 grams per sq. cm., and the average film density to be 0.7. For more accurate determination, of course, it is necessary to take into consideration the actual density of the material under investigation in order to determine the exposure factor, and the length of the area under exposure (528 and 737).

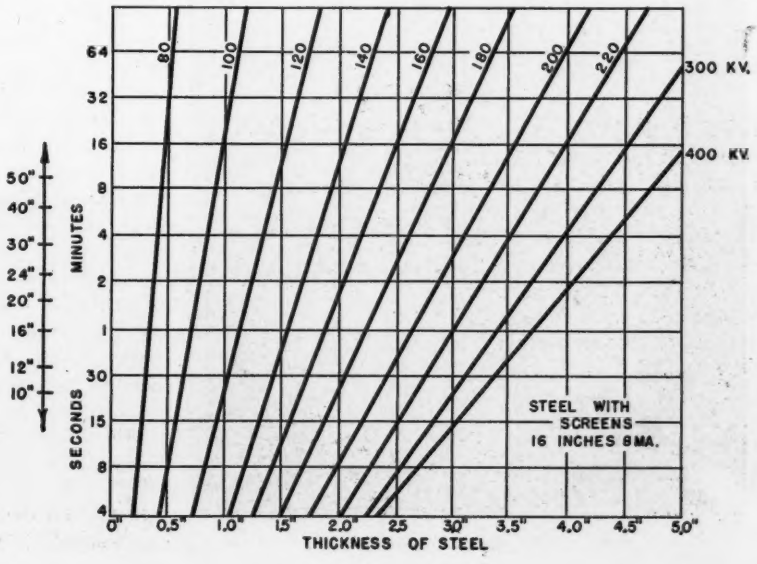


Fig. 3. Exposure Curves

For quick reference exposure conditions can be read off specially developed charts such as this. These values have been established at a 16 in. focus film distance. Correct exposure time for greater or smaller distances can be found by multiplying the 16 in. distance time by the amount of minutes found opposite the distance figure on the scale at the left hand side of the charts

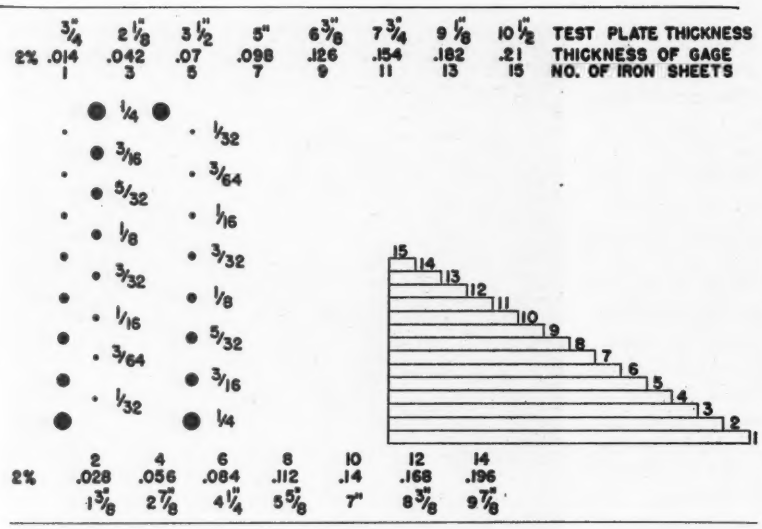


Fig. 4. The St. John Penetrameter

This is an arrangement to measure the penetration of x-rays. It consists of a step arrangement of thin metal sheets, each step ½ in. deep. Holes of various sizes are drilled in each step. The appearance of these holes proves the quality of definition

This does not make a great difference on thicknesses below 2 in. of steel, but above this it is quite important and should be observed carefully. At the greater thickness some filters should be employed to absorb undesirable scattered radiation coming from the steel itself. Thin filters of high-atomic weight materials have been developed, and these should be placed in front of the film. While the use of such filters requires an increase in exposure time, this is only half as much as was necessary before when a so-called Bucky grid was employed for this purpose of filtering scattered rays. Besides, the use of this heavy grid was cumbersome and retarded routine inspection considerably. The new filters are incorporated into the film holders and no movable parts are required.

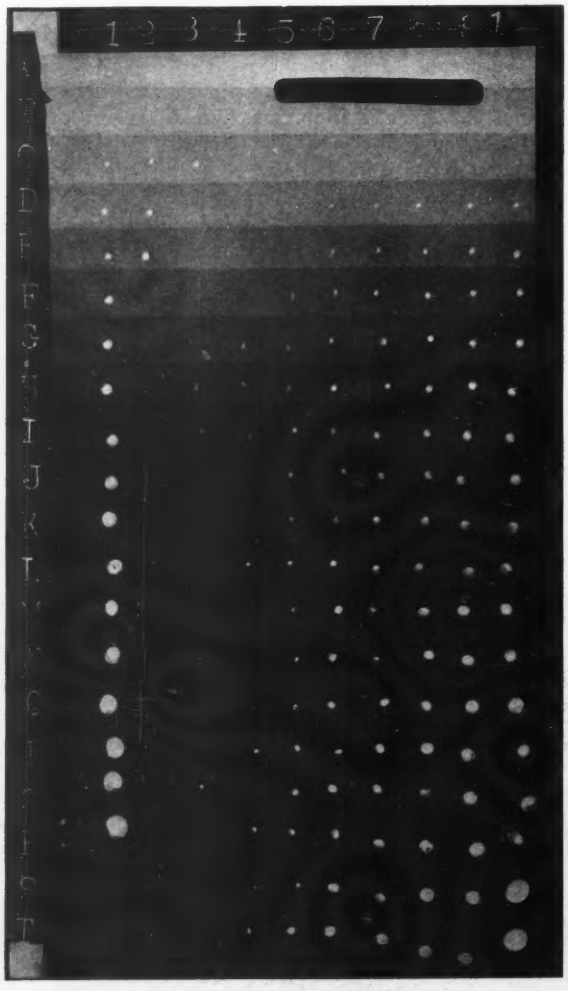


Fig. 5. Exograph of penetrameter

These new developments assure better results. These results can be judged by contrast and definition in an exograph. For test purposes we have developed a penetrameter to take care of this. It consists of a step arrangement of thin metal sheets, 10 inches long each and each step ½ in. deep, thus making the test specimen right for 8x10 in. film. Altogether we have 15 steps of various thickness. The appearance of these steps in the exograph is an indication of the quality of contrast. In addition to the steps, holes of various sizes have been drilled through each step, 8 holes in each step, all as indicated in Fig. 4. The appearance of these holes proves the quality of definition. When using the penetrameter it is important to place it in the approximate center of the test specimen in order to simulate actual field conditions where defects are more liable to occur at the inside of an object. The picture of our homemade first penetrameter is shown in Fig. 5. Here the holes are not drilled properly and more steps are shown than necessary. But it does illustrate the way we identify each hole and step by means of numbers and letters. Thus hole B8 which has a diameter of twice the size of its thickness corresponds to 4 per cent definition of a steel plate ½ in. thick or 2 per cent of 1 in.; whereas its contrast value is 2 per cent of ½ in. and 1 per cent of 1 in. of steel. Hole G4 has the same diameter as its step and represents 2 per cent in contrast and definition of 1¾ in. of steel. Hole N2 is 2 per cent in contrast and 1 per cent in definition of 3½ in. of steel. Hole D1 is 2 per cent in contrast and 6 per cent in definition of 1 in. of steel. Some systematic studies are still necessary and it is hoped

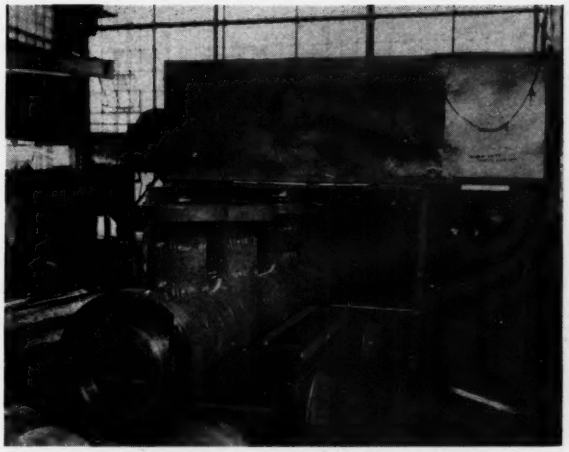


Fig. 6. 11-ft. long cast steel header to be X-rayed

Fig. 7. Field inspection of welded joint

that some such organization as the Fundamental Research Division of the Welding Research Committee of Engineering Foundation will sponsor this work.

Another great step forward can be registered through the development of the new ray-proof tubes. In previous years it was necessary to place the object under investigation inside a lead-lined enclosure as can be seen in Fig. 2. When dealing with large objects like a 3000-lb. header shown in Fig. 6, the construction of the lead enclosure was a major portion of an installation. Here is how it can be done today. Figure 7 shows the x-ray tube in front of a welded joint in a pipe line. On the other side of the joint is a lead box which contains the film holder. All that remains to be done in order to make this set up completely x-ray-proof is to place a lead apron over the tube. The x-ray equipment shown in this illustration is a portable unit which can be carried around by means of a small car as depicted in Fig. 8.

It may be of interest to learn something about the cost of x-ray work. Naturally, this will depend upon so many factors most of which are different in each instance. However, some idea can be gained from the following: 112 field welded joints are to be inspected in the field. Complete x-ray service with operators and darkroom facilities must be furnished. This and all materials, repairs, and so on amounted altogether to $11,371.00. For this amount the following work was performed:

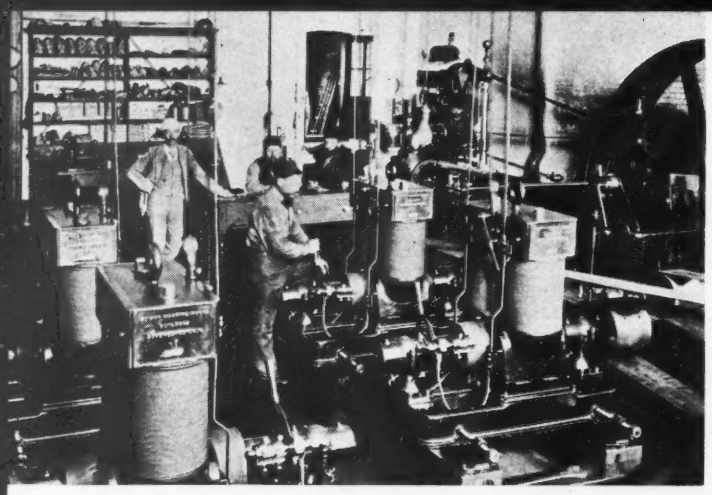
TABLE 1.

Welds in	Main Steam	Boiler Feed	200 lb. Bleed	Total x-rayed
x-rayed	33	65	14	112
Completely repaired	1	2	1	
Partly repaired	7	11	2	
Repaired twice	1	—	—	
Repaired without re-examination	—	—	2	
Total x-rayed repairs	9	13	3	25
Total joints x-rayed				137

Thus the approximate cost per joint is $83.00. This is high due to the fact that 28 per cent repairs were necessary. Ordinarily 10 per cent is a fair average. As far as time is concerned, this work was done over a period of three months and 1310 exographs were made on this job.

It thus has been shown that great advances have been made in recent years to make radiographic inspection more efficient so that more and more engineers can take advantage of this unique inspection tool. We admit that there is still plenty of room for improvement. Yet, this tool is available and even with its limitations offers a great aid to power plant engineers in general and to the operating men in particular. Because the latter ones are the men who have to live with the steam line, etc., whereas the engineers in the office have only their reputations, and maybe their jobs to lose if something should go wrong with the equipment, the operating men might lose their lives if a bad weld is made.

Fig. 8. Portable X-ray unit in transit



Ranges

Fig. 1—Back in the gay nineties when the present manager of the water and electric utilities, E. C. Schroeder, was meter reader and general utility man. At that time the plant was privately owned but the city purchased it in 1914 and embarked on a load building campaign and expansion plan which has been eminently successful

SINCE 1889 Manitowoc, Wis., has had electric service, and since the plant was purchased from John Schuette on Jan. 2, 1914, it has been operated as a municipal enterprise, administered with the water department, by a non-partisan, non-salaried board of five citizen members elected by the city council. When taken over by the city there were 2262 consumers, roughly 150 per thousand of population, and 1,272,000 kw-hr. were sold during the first year, giving an average annual consumption of 563 kw-hr. per customer. During the ensuing 24 yr. the population of Manitowoc has increased at an unusually uniform rate and was approximately 25,500 at the end of 1937. Users of electricity have increased much more rapidly and numbered 7100 in 1937, about 278 per thousand of population.

These customers of all classes, used a total of 16,986,000 kw-hr., giving an average consumption of 2392 kw-hr. annually. The total generation was 21,060,000 kw-hr., the difference in the two amounts being due to 459,000 kw-hr. for street lighting; 1,247,000 kw-hr. for the water department; 1,124,000 kw-hr. for transmission and other losses; 38,000 kw-hr. for office and store room lights; and 1,206,000 kw-hr. for excitation and station use.

12 DAY
66,300 LB./HR.
COCHRANE FLOW METER
5-17-38 #2
23,400 LB./HR. STEAM
61,000 K.W.H. TOTAL GENERATION / 24 HR.
34000 K.W.H. PLANT LOAD / 24 HR.
24 57,600 K.W.H. NET OUTPUT / 24 HR.
24,000 K.W.H. AVE. OUTPUT
4800 K.W.H. PEAK OUTPUT
12 NIGHT

Fig. 2. A typical week day steam load curve showingthe unusual a.m. peak due to electric ranges. This exceeds the evening peak by about one-third

On Mar. 1, 1938, a new rate schedule was put into effect. The residential schedule is 25 ct. per mo. for fixed charge plus an energy charge ranging from 2½ ct. for the first 50 kw-hr., per mo. 1¾ for the next 150 to 1½ ct. for all over 200. The commercial lighting schedule fixed charge is 40 ct. plus an energy charge beginning at 2½ ct. for the first 150-kw-hr. and scaling down to 1½ ct. for all over 500 kw-hr. For small power customers of 40 hp. or under, the rates range from 2½ ct. for the first 150 kw-hr. to 1½ ct. for all over 500 kw-hr. and for large users from 2.2 per kw-hr. for the first 50 hr. use of the monthly maximum demand to 0.75 ct. per kw-hr. for all over 200 hr.

Including the extension recently completed, the total generating capacity of the station is 11,500 kw. Four smaller units, one 300, one 750, one 1500 and one 2000 kw. units preceded the present installation. All have been removed and sold except the 1500 k.w. unit which is still in place in the old turbine room. This 150 lb. standby unit is tied into the 400 lb. boiler system by a Cash pressure reducing and Elliott desuperheating station.

In 1930 the building extension shown by Fig. 3 was made and two 800 hp., 400 lb., 150 deg. F. superheat Wickes 3 drum, bent tube boilers fired by Westinghouse stokers were installed. At the same time an Allis-Chalmers 5000 kw., 400 lb. turbo-generator and 7200 sq. ft. condenser was added in a new turbine room. This turbine room was the former 150 lb. boiler room from which six vertical water tube boilers were removed to make room for the new generator unit and switchboard, and provide space for future generating units. The first of these was added in 1935 and was practically a duplicate of the first 5000 kw. except that it was arranged for automatic extraction in anticipation of a heating load at some future date. All units generate at 2400 v., 3 ph., 60 cycle.

Condenser water is taken from an intake crib about 1500 ft., from the shore of Lake Michigan with the piping arranged for recirculation to prevent ice trouble, and, the condenser circulating pumps located in a separate pump house. Two Allis-Chalmers 7200 g.p.m., 31 ft. head circulating pumps are driven by Allis-Chalmers 75 hp. motors while a third pump of the same make and capacity but for 40 ft. head and driven by a 75 hp. Terry turbine is provided for standby. The circulating piping consists of cast iron pipe and valves with Ludlow checks.

Help Manitowoc's Load

Wisconsin city load increases 1500 per cent in quarter of a century and now it averages 957 kw-hr, per residential customer per year. Customers number about 84 per cent residential, 12 per cent commercial and 4 per cent power. Domestic and commercial lighting rates range from 2½ down to 1½ ct. per kw-hr., and power rates from a maximum of 2½ ct. for small loads down to 0.75 ct. per hr. of maximum demand for connected loads of over 40 hp.

The old switchboard and control equipment was left in the old plant and a new Westinghouse switchboard, circuit breakers and instruments added in the new turbine room as shown in Fig. 4. After the installation of the second 5000 kw. unit, sufficient space was left for a future 10,000 kw. unit.

Last year a third new boiler was added which, except for size, was practically a duplicate of the first two units. It is a 1200 hp. Wickes, 400 lb., 150 deg. F. superheat, 3 drum bent tube boiler with a Bigelow-Liptak setting and fired by a Westinghouse underfeed stoker designed for a maximum rating of 300 per cent. It is baffled for three passes, with 1400 sq. ft. of Elesco superheating surface in the first pass and a 6912 sq. ft. Foster Wheeler separate economizer at the rear.

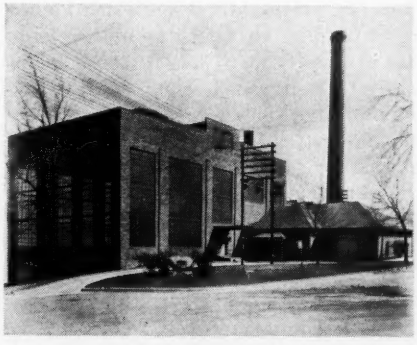


Fig. 3. The plant as it looks today. The garage at the right is all that remains of the old pumping plant that originally stood on this spot. The new boiler is in the near corner with space beside it for another unit. The turbine room in back also has room for expansion

A Clarage, Size 9 Type RT induced draft fan, dual driven by a Westingnhouse 85 hp. turbine and a 100 hp., Allis-Chalmers motor discharges to a steel stack on the roof with the duct work so arranged that another boiler unit, also with an induced draft fan, can be added at a later date in space already provided in the building. The forced draft fan is in the basement. It is also a Clarage, Design 1, Size 3½ and driven by a Westinghouse 60 hp. motor and a Westinghouse 61 hp. turbine. Although each of the three boilers have individual forced draft fans, the duct work is arranged so that the fans can be operated in parallel if desired.

Each unit is provided with a Hays boiler panel with a 6 pointer draft gage, a CO_2 recorder, pressure and temperature recorders and a Cochrane recording and integrating flow meter. The Freeman-Riff coal handling system installed in 1930 also serves the new unit. Ash from the Freeman-Riff ash hoppers is dumped on the basement floor and loaded into trucks by a portable conveyor. To supplement the two 175 g.p.m. Allis-Chalmers dual driven boiler feed pumps originally installed, a 275 g.p.m., 1300 ft. head pump driven by a 150 hp., 3500 r.p.m. motor was added and the main steam header was paralleled with an auxiliary header of Crane pipe and Walworth valves with Armstrong traps for drainage. Other equipment includes: Diamond sootblowers, Reliance water columns; Crane safety valves; Edwards blowoff and stop and check valves; and a Cochrane hot process softener and open feedwater heater utilizing the auxiliary exhaust.

During April of this year the load ranged from 43,000 to 60,000 kw-hr. per day with an average of about 52,000. The heat rate averaged 22,300 B.t.u. per kw-hr., giving a thermal efficiency of 15.26 per cent and a coal rate of 1.74 lb. of coal per kw-hr. Figure 2 shows a typical day's performance with a large peak just before noon due to the large number of electric ranges. In addition to the ranges there are a large number of off-peak water heaters which carry a special rate of 1 ct. per kw-hr. and average about 2500 kw-hr. per heater per year.

E. C. Schroeder is manager of the Water and Electric Plants and W. C. Staeffler is assistant secretary. G. C. Dueno is chief engineer of the power plant and P. J. Gilbert is technical engineer.

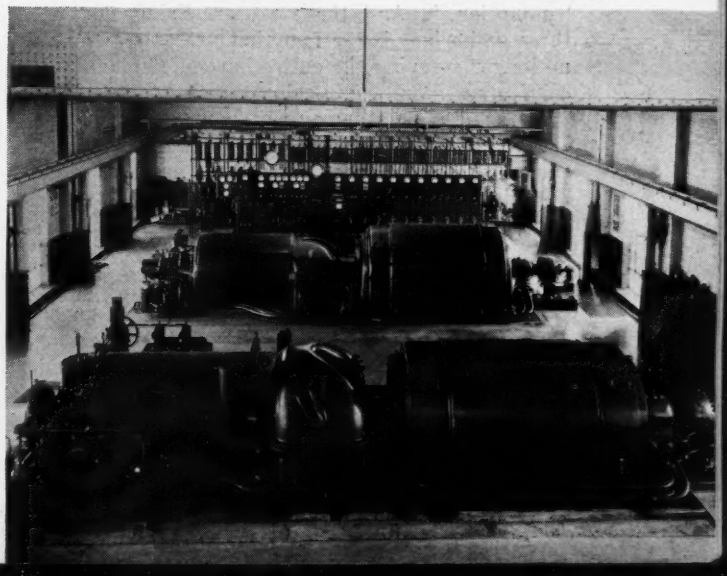


Fig. 4. Today the plant has a generating capacity of 10,000 kw. in two units which operate at 400 lb. pressure

Engineering Gumption

By Lawrence M. Duryee

APPLEWOOD is burning on my hearth tonight. There is nothing, I think, that is quite as soothing, as peaceful, and as conducive to constructive thinking as applewood burning on one's hearth. Especially if one has sawed, split and hauled in the wood himself!

In the blue smoke that is curling lazily upward I see my old friend, Dr. David Starr Jordan—educator, philosopher, scientist. He's dead now. I was a mere undergraduate when he was president of my alma mater. The picture that appears so vividly before me is that of Dr. Jordan sitting comfortably and informally in his spacious living room, giving us one of those splendid talks which only he could give.

"The educated man," he said, "is the man who does what should be done, at the time it should be done, and whether he wants to do it or not. And let me remind you," he added, "that it takes a lot of gumption!"

I can hear that word "gumption" plainly, see the bristle of that white mustache, and feel the fire and sparkle in his eyes.

GUMPTION—plain, simple, unqualified, free from fancy trimmings—means common sense. Engineering gumption—scientific common sense—should be the heritage of every engineering graduate in the land. How can it be attained to the fullest extent, and in its most effective form?

Princeton University has recently held a series of unusually interesting meetings, attended both by heads of industry and engineering professors. The most important topic of discussion has been the selection and establishment of a curriculum for engineering students that will best fit them for employment. Boiled down to its simplest terms, the approach being made to the problem of engineering education in these very timely discussions is simply an approach to more "gumption." And the most promising feature of these gatherings is the fact that professors alone are no longer carrying the entire burden of planning the curriculum for engineering students. Industrial leaders and plant managers are now taking their part. They realize as never before that specifications for "men" are far more important than specifications for materials. And above all, men with gumption are sorely needed.

Beer Barrel Technique

The other day I watched a young engineering graduate trying to perform an unusual task in a brewery. He'd been given instructions to knock apart some old wooden beer kegs. The staves making up the barrels were of sturdy, half-inch oak, bound securely in place by iron hoops. He stood there, bending over a barrel, working with a peculiarly shaped hammer. At every stroke the young man was endeavoring with great enthusiasm to hit the edge of an iron hoop. But the hammer, having a long narrow face and weighing considerably more than most hammers, made contact with the hoop only once in eight or ten blows. Result: in a half hour the young man had broken up only four barrels. Came the "boss," the brew-master. He surveyed the scene at a glance. Then, quietly, he grasped the peculiarly shaped hammer in his left hand, placed it on the edge of an especially obstinate hoop, and struck it deftly with another—an ordinary hammer—which had been lying nearby. Instantly the hoop dropped to the ground, and so did all the rest. The barrel was completely demolished in thirty seconds, because each stroke of the right-hand hammer went to the exact spot for which it was intended.

For the first time in his barrel-breaking career the young engineer was confronted with a perfect example of the value of gumption. It was demonstrated to him most convincingly by a man who'd never had the advantage of a high school education. Hyperbolic parabaloids and Mollier diagrams were like child's play to the young man—but a self-made brew-master showed him how to break up beer barrels! Had the young man been trained to a quick and practical analysis of a situation, he would have realized almost intuitively that the peculiar shape of the oblong hammer that had been given him to loosen those hoops lent itself perfectly to being hit, but not at all to hitting! Would he not have shown good common sense by at least inquiring first as to the proper use of that hammer before wasting a precious half-hour? That wasted half-hour can never be regained.

Education in Slivers

Another young engineer started out after graduation to learn, from the ground up, the business of generating, transmitting and distributing electric power. He spent a year in a power plant, firing boilers, operating turbines, testing switch-gear, etc. Then he began his apprenticeship with the "line gang." His first month there was pure drudgery. He reeled and unreeled heavy cable, carried cross-arms, and dug six-foot holes in the ground until his back ached. Then the line foreman dropped a casual hint one day that he'd better "start climbin'."

So the embryo engineer, filled with importance at this call to a real lineman's job, strapped on his first pair of "hooks." That very day, while the "gang" was eating lunch, he would practice this gentle art of pole-climbing. Nonchalantly he approached a nearby pole, grasped it firmly with his hands, and sank his right hook home. He put all his weight on it—and it held. Encouraged, he sank his left hook into the opposite side of the pole. It, too, held. Slowly, carefully, he made his way upward. The gang sat in the shade of a tree, eating—and waiting. Step by step he made his way aloft. About 20 ft. from the ground—just under the cross-arm—he stopped to look about him.

This was his first attempt and it was a long way down. What dizzy heights he'd climbed to! Beads

of perspiration broke out on his forehead. Panic seized him. At this point instinct told him to hug the pole with his knees—never mind the hooks! He did. The result was swift and certain. His hooks broke loose from the wood and he clung to the pole with both arms and legs. He was utterly unable to sink those hooks back into the wood again. More perspiration broke out. Finally, completely frightened now, he started sliding down the pole, shinneying, like a fireman. Ten feet from the ground, panic-stricken and almost exhausted, he half slid, half dropped to safety. He landed with a jolt, as dejected and helpless a groundhand as ever dug a hole or threw a handline.

LOOK FOR THE SILVER LINING

Carefully, painfully, he began extracting long chestnut splinters from his arms and legs. Then hilarious laughter broke loose from the gang, sitting there under the tree. When the uproar had partially subsided the foreman came over to him. "Next time you try climbin', Buddy," he said kindly, "remember to stay as far away from the pole with your body as you c'n get. That's the only way you'll ever be able to sink those hocks back into the wood again. And don't forget this—never look down from a pole until you're absolutely sure you're used to the job o' climbin'!"

The young engineer remembered the episode long after the foreman had forgotten it. Months passed ere the last vestige of chestnut was finally removed from his legs. And how utterly unnecessary it all was! For if he'd shown ordinary common sense—just plain gumption—he'd have inquired into the proper use of the hooks before elevating himself 20 ft. up in the air. I know this story is true; I was that young engineer.

Louis Agassiz, scientist, scholar and great teacher, inscribed on the walls of his class-rooms the following motto:

"Be Not Afraid to Say—'I Do Not Know'!"

He put this motto into daily use and became the greatest naturalist of his day. The impulse of his work is deeply felt in every field of American scientific achievement.

Engineering courses in our colleges are sorely in need of developing in our young technicians a practical approach to everyday problems as well as the theory involved in higher mathematics. Gumption, in this changing world of ours, is definitely at a premium.

Metal Cutting Torches

GREAT sections of steel up to 4 ft. thick today are being cut by the oxy-acetylene process. The oxy-acetylene flame, which generates a temperature of about 6,000 deg. F., is produced by burning a closely regulated mixture of oxygen and acetylene in a suitably designed blowpipe. The flame is focused upon the surface of the steel until it becomes red hot. Then a jet of oxygen is released upon the heated spot. The oxygen jet cuts through the steel in an instant, and by moving the blowpipe, the flame makes an effortless slice through the tough metal.

Radisson Hotel Modernization

AN intrinsic part of the $250,000 modernization program of the Hotel Radisson in Minneapolis is the extensive additions and alterations which are being made in the mechanical equipment of the building. The entire program is under the direct supervision of Ira N. Soper, prominent consulting engineer of Chicago.

While a good portion of the expenditure is for replacements of equipment a large share is being made to increase guest comfort. For instance, many new shower bath facilities have been installed with a consequent heavier demand for hot water supply and two new hot water heaters of 2000 gal. storage and 3000 gal. instantaneous capacity have been installed. One of these heaters will be used solely for the supply of hot water to the guest rooms and it is equipped with thermostatic control. The second heater will be for furnishing hot water to the laundry and kitchens. This heater is also equipped with thermostatic control so that hot water will be supplied at sufficient high temperature for sterilization of the dishes at the dish washing machines and for proper operation of the laundry.

Extensive piping alterations are being made and new heating pumps installed to promote good room heating results.

The present central system of refrigeration is being replaced with the unit system including new refrigerators in the kitchen and complete remodeling of ice making equipment. Many guest rooms have been equipped with unit air conditioners for summer cooling.

Two of the original boilers have been removed and one new Bros boiler is now being installed. This new boiler is of the type commercially known as a four-drum bent tube, water tube type of 340 hp. nominal rated capacity and capable of developing 250 per cent of rating when stoker fired. The boiler will be equipped with a superheater and fired by an over feed type of stoker. A complete system is being installed for the automatic control of the boiler and stoker as a unit. New boiler accessory equipment, such as boiler feed pumps and feedwater heater, is now being installed. Proper recording and indicating instruments are being furnished to enable the engineering staff to operate the boiler at its maximum efficiency.

The boiler will be operated at approximately 150 lb. working pressure and 100 deg. superheat and is of ample capacity for the total steam demand for electric power and lighting generation, high pressure steam for laundry and kitchen service, together with additional live steam for heating at such times as when the exhaust steam supply is not sufficient. The type of stoker and control system is such that the unit is expected to operate at approximately 78 per cent overall efficiency with loads varying from 100 per cent of boiler rating up to 250 per cent.

The installation of more modern equipment has made possible a reduction in the electric power load sufficient to provide ample power from present generating equipment for future additional air conditioning.

Another New Diesel

Chrysler enters field with a new Diesel, rated 95 hp. at 2600 r.p.m., developed primarily to power Dodge 3-ton trucks

FOLLOWING a decade of development and many thousands of miles of road service, the Dodge Truck division of the Chrysler Corp., Detroit, Mich., announces a new Diesel engine which in general dimensions, mountings and crankcase structure is identical with the Dodge 3-ton truck gasoline engine. The engine, of the six cylinder, 4 cycle type has a 3¾ in. bore and 5 in. stroke and a compression ratio of 14.5 to 1. It has a displacement of 331 cu. in., a torque rating of 226 ft. lb. at 1000 r.p.m. and power rating of 95 hp. at 2600 r.p.m. The electrical system is 24 v. throughout with an electric air heater located in the intake manifold to facilitiate starting in cold weather. Design limitations forced the departure from the Dodge traditional L-shaped combustion chamber and the new engine employs overhead valves. The port diameters the intake and exhaust valves are 1.546 and 1.312 in. respectively, the lift in both cases being 0.375 in.

The combustion chamber, located in the cylinder head, is of the double-O shape with an auxiliary double chamber energy cell as shown by Fig. 2 and a pintle type nozzle to give maximum freedom from plugging and carbonizing. Each cylinder is provided with a fuel injection pump cylinder and the axes of the six cylinders are arranged parallel to, and concentric with, the axis of the pump drive shaft and mechanism. The pistons are driven through tappets held by spring pressure in contact with a single rotating swash plate. Each cylinder is connected to a central fuel supply chamber through a port which is uncovered during the intake stroke of the pump piston and covered only during that period of the delivery stroke when injection to the engine at high pressure through the delivery port is desired. This is done by means of a shaft rotating, within the supply chamber, and carrying a valve with one triangular shaped section, or, land, which, in passing over the port, closes it.

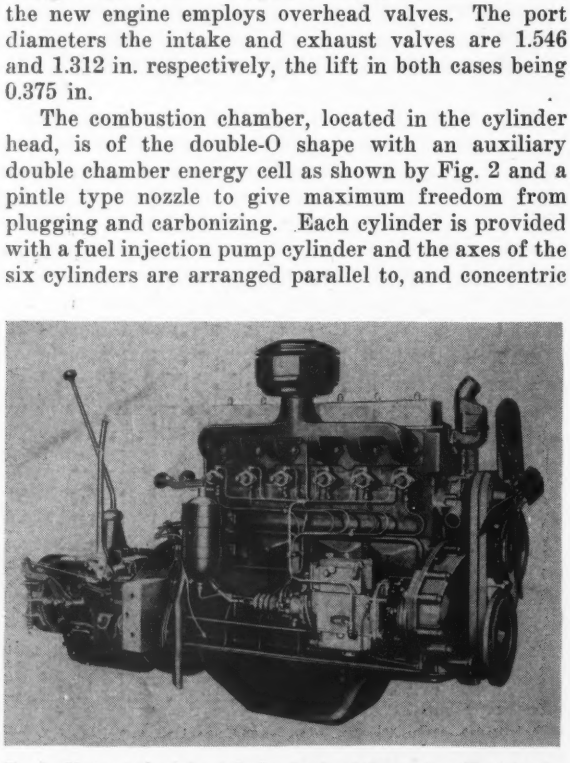


Fig. 1. Photograph of the right hand side of the engine. The injection pump is mounted at the side with the six injection pump cylinders arranged parallel to, and concentric with, the axes of the pump drive shaft. Pump pistons are operated by a rotating swash plate. The rotating fuel valve may be displaced axially or angularly to give control both to the time and duration of injection

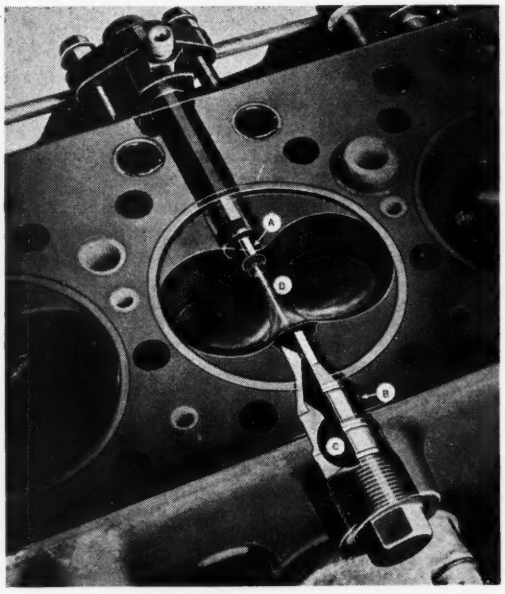


Fig. 2. Arrangement of the injector valve and cylinder of the new engine. Fuel is injected from the pintle type nozzle A and initial combustion of the fine spray takes place in the main combustion chamber D. The core of the spray, however, enters air cell C where it is partially burned, developing a pressure which sprays the remainder of the fuel back into the main combustion chamber with intense turbulence

This rotating shaft and valve are arranged so that they may be displaced both axially and angularly. The latter displacement, controlled by a second set of governor weights, creates a change in the phase relationship of the rotating valve and the engine crankshaft. As the engine speed increases, the angular position of the rotating land is set ahead so that in turning it closes each port sooner than it otherwise would. This gives automatic control of injection time so that instead of providing fixed injection advance with maximum operating efficiency at only one engine speed, the Dodge pump automatically times the start of injection at the optimum point. Axial movement of the shaft is accomplished by a mechanical connection to the accelerator pedal and thus controls the amount of fuel delivered to the engine. It is also subject to control by a centrifugal govenor so that the maximum speed cannot be exceeded.

Road service indicates, it is said, fuel economy consistently 40 per cent better than comparable gasoline engine performance with no indication that there will be an appreciable difference in the maintenance costs of the two types of power units.

Tests show the effect of superheat on small compressor performance at different suction pressures and serve as an accurate basis of correction for changed conditions.

Effect of Superheat on Compressor Performance

By L. W. CHILD*
Evans Products Co.
Detroit, Mich.

SELECTION of the proper capacity unit for a given refrigerating load has been greatly simplified since the advent of standard methods of rating. Since these ratings are given with a vapor temperature of 65 deg. F. entering the compressor, however, the engineer is somewhat at a loss as to expected capacity, if inlet temperatures vary from this figure. The installation may call for a short connection from an ice cube freezer to the compressor, giving inlet temperatures around 15 deg. or, it may call for running the suction line through a maze of steam and hot water pipes, ending up with a temperature of 130 deg.

Again, he might like to specify a heat exchanger between liquid and low side vapor lines, but has no data available to justify this expense. Therefore, tests were made with the object of giving some idea of what can be expected under conditions other than standard, when using a commercial condensing unit, The results of the tests are given in the accompanying curve sheets.

The usual method of figuring the capacity of a compressor at inlet temperatures higher than standard is to assume the volume compressed will be constant and then correct for the new specific volume of the vapor. For example, referring to the tonnage curve for 30 lb. per sq. in. evaporator pressure, the rating for the compressor will be 0.89 t. at 65 deg. F. If this compressor were to be operated with 100 deg. inlet vapor, and it was assumed that the same c.f.m. of vapor would be handled, the new tonnage rating would be proportional to the ratio of specific volumes at 65 and 100 deg. F. for 30 lb. gage refrigerant, or 0.89 (0.98 ÷ 1.06) = 0.823 t.

Corrections from Tests

Actual test results, however, give 0.88 t. or 7 per cent greater capacity than expected. The error caused by this assumption of a constant volumetric efficiency becomes more important at lower evaporator pressures and temperatures, since the method tends to give greater capacities than shown by actual test. Taking the capacity at 11 lb. gage, evaporator pressure, and 65 deg. F. as 0.43 t. and reducing the inlet temperature to 20 deg. F., this method would show a new capacity of 0.43 (1.75 ÷ 1.58) = 0.476 t.

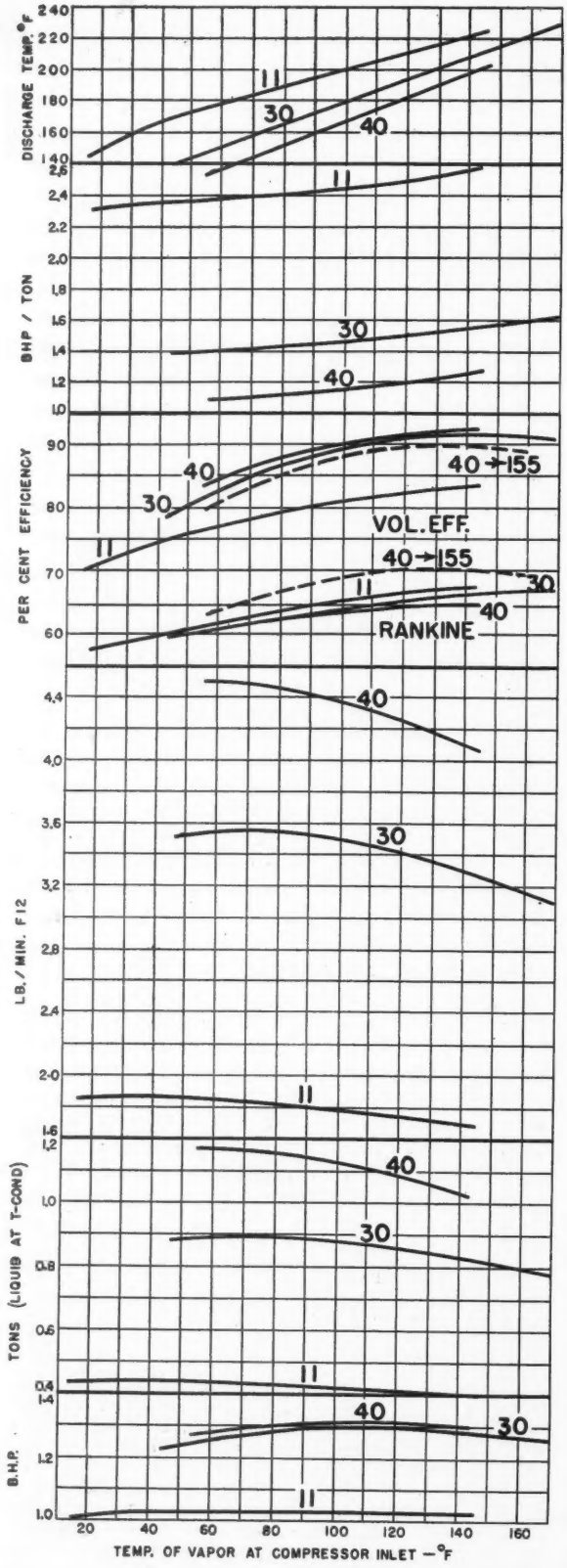
Test results show only 0.44 t. or 8 per cent less than expected. Again, under this method, it is common to assume the power consumption to be constant since the same volume is handled at the same pressures. A glance at the b.hp. curves shows that a variation in power may be expected and although not great, can be sufficient to overload a motor that has been closely figured, a somewhat common practice.

Heat Exchangers

Effect of a heat interchanger between liquid and return vapor lines can be readily determined from the curves given. Assuming the unit to be operating at 120 lb. per sq. in. ga. condensing pressure and 11 lb. evaporating pressure, without an exchanger, and vapor at 20 deg. F. entering the compressor, the rating will be 0.44 t. and 1.01 b.hp. Assume a heat exchanger, receiving liquid at 102 deg. F., and heating the vapor from 20 to 90 deg. F., to be placed in the system. The effect of this interchanger is shown in the solution in the accompanying table.

B.t.u. per lb. of vapor at 90 deg. F.	=	91.06
B.t.u. per lb. of vapor at 20 deg. F.	=	80.90
B.t.u. per lb. removed from liquid	=	10.16
B.t.u. per lb. of liquid at 102 deg. F.	=	31.65
B.t.u. per lb. of liquid removed	=	10.16
B.t.u. per lb. of liquid entering evaporator	=	21.49
B.t.u. per lb. of sat. vapor leaving evaporator	=	78.65
B.t.u. per lb. of liquid entering evaporator	=	21.49
B.t.u. per lb. available	=	57.16
Pounds per min. with compressor at 90 deg. F. inlet and 11 lb. per sq. in.	=	1.80
Capacity = (57.16x1.80) 200 = 0.514 t.		
Capacity without interchanger = 0.44 t.		
Increase due to interchanger = 17 per cent		
B.hp. at 90 deg. F. and 11 lb. per sq. in.	=	1.03
B.hp. at 20 deg. F. and 11 lb. per sq. in.	=	1.01
Increase in b.hp. = 2 per cent		

*This is an abstract of a paper "The Effect of Superheat on Condensing Unit Efficiency" presented before the 33rd Annual Meeting of the A. S. R. E. and published subsequently by the Society in Refrigerating Engineering.



Tests were made on a 2¼ by 3 in., 2 cyl. air cooled compressor using Freon-12 and belt driven at a constant speed of 300 r.p.m. Inlet temperatures were varied for three suction pressures if 11, 30 and 40 lb. ga. as indicated on the curves. Head pressure 120 lb. except for the two curves marked 155

This increase certainly justifies the use of an interchanger for this particular set of conditions. However, the interchanger will naturally be found to give smaller increases in capacity with higher inlet pressures. For example, if used on this compressor at 40 lb. per sq. in., it will give only a 7 per cent gain in tonnage, with a 1.5 per cent increase in power.

Again, referring to the curves, it will be noticed that the temperature of the vapor leaving the compressor will be substantially increased, as the inlet temperature is increased. Considering the poor rate of heat transfer generally found with superheated vapor, this increase in temperature is bound to give an increased load on the condenser, and so tend to raise the horsepower, as well as the temperature of the liquid.

Volumetric Efficiency

Volumetric efficiency curves show a rather surprising rise with inlet temperatures which may possibly be attributed to the presence of small droplets of oil, saturated with Freon, in the inlet vapor, plus the bare possibility of some liquid itself being present.

Rankine efficiency curves show the amount of power required to operate the compressor, as compared to the theoretical power required to compress the same quantity of refrigerant adiabatically, under the same inlet conditions. It is used in place of the Carnot efficiency because it does not charge the compressor with inefficiencies due to the cycle. This is the reason for the apparent discrepancy between the b.hp. per ton and the efficiency curves.

Normally a decreasing efficiency would be expected with an increasing b.hp. per ton curve. However, in this case the reverse is true, because the cycle calls for a considerable increase in power per pound of refrigerant, as the superheat of the inlet vapor is increased. The increase in Rankine efficiency, with increasing inlet temperatures, is probably caused by the compression line approaching an adiabatic, as the temperatures of the compressor increases, due to the increased rate of heat dissipation, caused by this increase in compressor temperature.

Test Conditions

The results of the tests run at 40 lb. gage inlet pressure to 155 lb. gage head pressure, are only given on the efficiency curve sheet, where they appear as dotted lines. They are included to show that the compressor follows the same general trend with higher head pressures, as it does at 120 lb. head.

These results were obtained with a single compressor, but it is difficult to imagine that similar compressors, using the same or similar refrigerants, will vary widely from this test, as far as the general shape of the characteristic curves is concerned.

In the opinion of these authorities, it has been almost impossible to make definite recommendations relative to water treatment to prevent embrittlement other than to say that the water should conform to the A.S.M.E. Boiler Code recommendaions which were based upon boiler operations of years ago when few boilers were operated above 300 lb. steam pressures.

Application of Vacuum Cooling

Low first cost, simplicity and recent improvements make this equipment competitive for temperatures of 40 deg. F. and above.

By J. W. McNULTY
Westinghouse Elec. & Mfg. Co.,
South Philadelphia, Pa.

EVER INCREASING requirements for refrigeration by the industries and for air conditioning has given new impetus to the use of steam jet apparatus, and, many improvements in design have been made in the past few years. It is now a fact that the operating economy of the steam jet type, for producing water temperatures of 40 deg. F. and above, is as good or better than can be obtained with mechanical types, on the basis of one cent per kilowatt hour power costs and steam at fifty cents per 1000 lb.

Because the developments resulting in these remarkable economies are of comparatively recent date, refrigeration users are not as familiar with steam jets as they are with the mechanical types. Consequently, when buying new refrigeration capacity, the possibilities of the steam jet type are often not considered. It must be admitted that the field for application of steam jet refrigeration is limited, but on many jobs it works out to a definite advantage.

Aside from the advantages of lower first cost, maintenance and comparable or lower operating costs, there are those of simplicity, no moving parts to cause wear and vibration, the use of water only as a refrigerant, eliminating expensive and obnoxious chemicals, and wide distribution of weight loads, minimizing foundation problems. Another feature, often desirable, is the complete deaeration of the chilled water as it passes through the evaporator.

The principle upon which the steam jet apparatus operates is clearly illustrated in Fig. 1. There are two separate and distinct water circuits involved, the condenser cooling water circuits, and the chilled water circuit. The former is similar to that employed in the conventional power plant steam condenser, wherein the heat from the motive steam and heat of evaporation delivered to the condenser by the steam jet or booster ejector, is absorbed by the condensing water in the condenser, and is thus dissipated in the usual manner. The latter is a simple circuit, wherein the heat absorbed in the process, or air conditioning system, is carried into the evaporator by the chilled water where it is extracted and the temperature of the chilled water lowered, by the evaporation of a portion of the chilled water.

This heat is removed from the evaporator by the steam jet in the form of saturated steam, and is delivered, together with the motive steam used by the jet, into the condenser. Thus each pound of steam removed by the jet results in removing approximately 1000 B.t.u. from the body of chilled water. This evaporation within the evaporator is made possible by the high vacuum or low absolute pressure maintained in the evaporator by the jets.

Vacuum and Temperature

The vacuum which must be maintained within the evaporator is a function of the final temperature of the chilled water produced and corresponds approximately to the temperature pressure relationship for saturated water vapor as given in the steam tables.

Design of the evaporator must be such as to cause the incoming water to be broken up into small droplets and to permit these droplets to remain suspended an appreciable period of time before combining with the body of water in the bottom of the evaporator. If this is not accomplished, it will necessitate maintaining a lower absolute pressure in the evaporator than that corresponding to the final water temperature.

This is apparent, if we consider one individual droplet of water as it enters the region of high vacuum within the evaporator. Evaporation from the droplet occurs over the surface and the surface layer is instantaneously cooled. The center, however, tends to remain at the higher temperature, and the heat must be conducted through the water comprising the mass of the droplet, to the surface layer, where it in turn is dissipated through evaporation. This requires a time factor, and the time factor can be reduced to a minimum by reducing the average size of the droplets which increases the ratio of surface, or evaporating area to the mass of the droplet, and also reduces the distance that the heat at the center of the droplet must travel, to reach the surface layer. Careful tests have shown that with a correctly designed evaporator there is no appreciable deviation from the theoretical relationship of temperature and pressure.

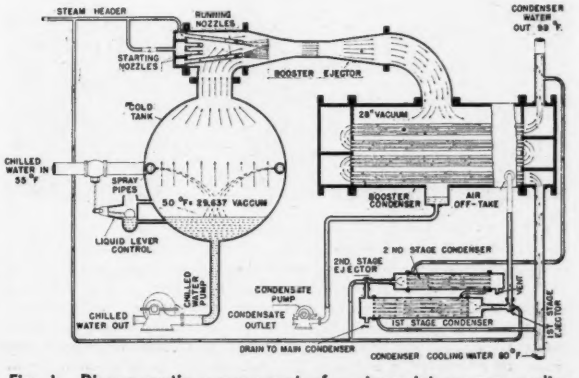


Fig. 1. Diagrammatic arrangement of a steam jet vacuum cooling system. Note that these are two separate and distinct water systems one on the right, the other on the left hand side

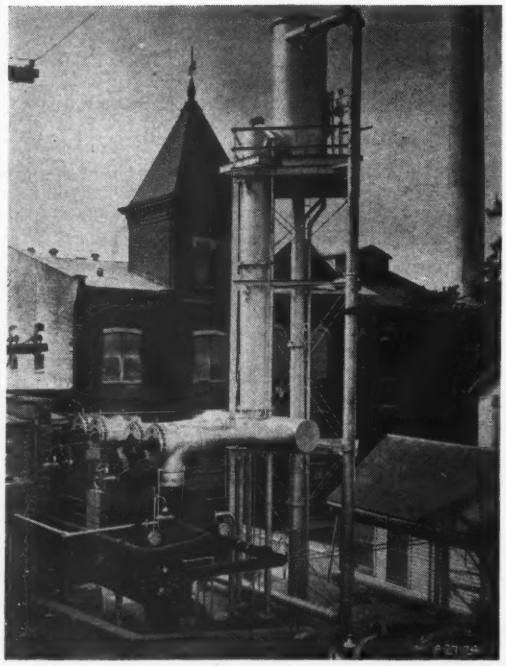


Fig. 3.—Installed in 1935 at the George T. Stagg Co. distillery at Frankfort, Ky., this unit has 403 t. capacity at 55 deg. F. and is used for cooling yeast and mash. Four boosters of equal capacity, three of which are under automatic control to cut in or out in response to load. This unit is installed in the open and the boosters exhaust into a barometric condenser as shown.

There is a natural tendency for the finer droplets of water from the spray to be entrained by the vapor and carried into the jets and thence to the condenser. This carryover results in a loss in efficiency and is, therefore, undesirable. It can be reduced to a minimum by either installing zigzag moisture eliminators between the evaporating zone and the jet inlets or by enlarging the evaporator to maintain vapor velocities so low that practically no entrainment occurs. The latter design is preferable, since the pressure drop across the eliminators is avoided, and the efficiency thus improved.

Make-up water is added to the chilled water system through a float valve to compensate for the evaporation carryover and mechanical losses. The chilled water is removed from the evaporator by a specially designed high vacuum pump and is completely devoid of air and other gases.

In designing steam jet refrigeration units the designer enjoys an unusually wide latitude in which to work, since the vacuum within the condenser can be set at the most advantageous point, and thus the quantity of operating steam and condensing water used can be balanced to give the lowest operating cost for the existing condition.

These units also possess unusual operating flexibility at partial loads since it is only necessary to operate enough boosters to carry the load, and no steam is consumed by the idle boosters. This can be carried a step farther, by reducing the steam pressure to the operating boosters at fractional loads, or when the condensing water is below the design temperature. Under these conditions the condenser vacuum increases, decreasing the compression ratio between the evaporator pressure and the condenser pressure, and thus the quantity of motive steam required by the boosters decreases, almost in direct ratio to the increase in condenser vacuum.

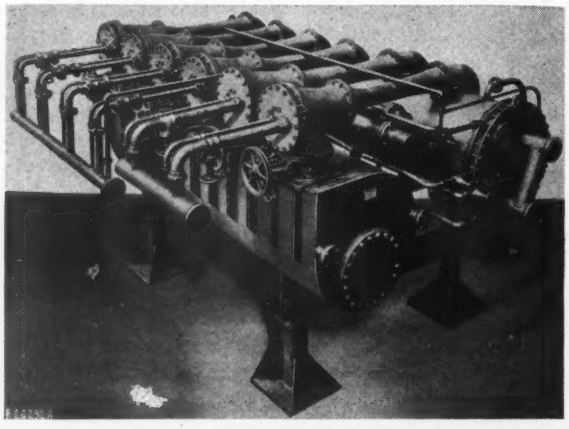


Fig. 2. The equipment itself looks like this. The different parts can be identified by comparing with Fig. 1. The above equipment, used for air conditioning, was installed in the Statler Hotel in Detroit in 1934 and has a total capacity of 171 tons at 47 deg. F. Four boosters in the rear operate on high pressure steam and produce 30.25 t. each. The other two operate on 2 lb. ge. steam exhausted from CO_2 compressors and produce 25 t. each. The Chicago Tower Building in the same year, installed a unit with six boosters and a total capacity of 600 t. at 43 deg. F. Both of these installations were preceded by a 156 t. (at 40 deg. F.) unit at the 60 Wall Tower Building in New York City

"Torque Motor" Solves Meter Control Problem

WHERE it is necessary to maintain constant flow-rate in a pipe-line irrespective of changes in the "head" of the supply source a wash meter control operating a power-driven valve is used. If motors are employed for such service, they must be able to withstand constant stopping, starting and reversal, and the conditions are therefore unusually severe. They must also develop high starting torque in order to actuate the valve against the pressure of the water or other liquid handled.

The Simplex Valve & Meter Company, Philadelphia, Pa., solves the problem as follows. A combination of a flow-meter and a control switch operates an "Ohio" torque motor which is connected through gearing to a butterfly valve located "downstream" of the throat of a venturi tube. Thus when the "head" of the pipe-line is being diminished, the butterfly valve gradually changes its opening so as to maintain the desired rate of flow. For various practical reasons it is not feasible to cause the valve to open in one direction only, and it is therefore allowed to open a little too much and then to close a trifle until the opening is correct. Ohio "torque motors" have been selected for this work because of their ability to withstand the constant reversals year after year. In fact, they can exert full torque with only full load current even when stationary, and can be furthermore repeatedly "stalled" on the line at full voltage without injury—a characteristic which renders them also applicable to such services as closing elevator gates, operating automatic contactor devices, etc.

Capacity of Power Equipment

Its effect on continuous, low cost steam generation

By J. G. WORKER
Amerian Engineering Co.

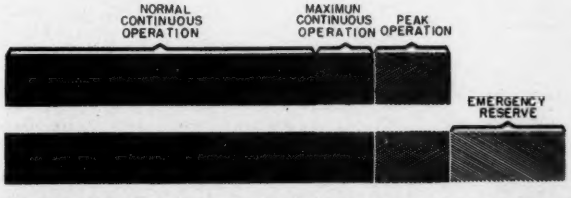
RELIABILITY is the first requirement of steam generating equipment. This was briefly discussed on page 579 in the September 1938 issue of POWER PLANT ENGINEERING. When you are satisfied that the equipment you are considering will operate reliably, the next important consideration is that of capacity.

There are two primary questions which must be answered regarding capacity (1) Are prime capacity ratings adequate? (2) Is there sufficient reserve capacity for emergencies?

PRIME CAPACITY

Adequacy of prime capacity calls for the assurance that the equipment selected will furnish a safe margin of capacity—so that its normal operations are not taxed beyond normal capacity ratings for continuous, maximum continuous, and peak operating periods. As a simple illustration of this point—suppose you were purchasing a truck for hauling ashes and found that the average load would total about 6 t. Instead of buying a 6-t. truck with the expectation of running it fully loaded, it would be wiser to buy a truck of 7½ t. capacity so that you could be sure of operating it without overloading. Obviously it is equally unwise to underestimate the capacity of steam generating equipment. Actually it is economically sound and practical to buy oversize equipment.

The wisdom of providing sufficient prime capacity is more than justified in those cases where the need for additional prime capacity increases soon after installation beyond initial expectations. We could cite many cases among our own experiences where operators were thankful they had just a little more capacity than they regarded as adequate.



This chart shows the zones of normal-continuous, maximum-continuous and peak operation and the emergency reserve capacity extending beyond all three. Emergency reserve capacity may mean the difference between continuous plant operation and forced shut-down.

EMERGENCY RESERVE CAPACITY

The other consideration, that of emergency reserve capacity, may represent the difference between continued plant operation and forced shut-down.

A steam generating unit is a combination of many individual elements such as the stoker, boiler, waterwalls, preheater, economizer and so on. Failure of any one may throw the complete unit out of service. The load must then be shifted onto other units during the emergency period until repairs can be made.

It is important to know before you purchase steam generating equipment whether, in an emergency such as we have described above, that other equipment onto which the emergency load has been shifted can generate steam in excess of its peak capacity for prolonged periods.

The actual period for which the emergency exists may be a matter of hours, days or even weeks. It becomes especially serious in a plant where the load is normally divided among only two units.

Remember that the power plant is the heart of your enterprise, whether it be an industrial plant, college, municipal plant or central station. One forced shut-down through lack of ample reserve capacity may make the entire plant inoperative at a loss far greater than the slight additional cost for providing ample reserve capacity.

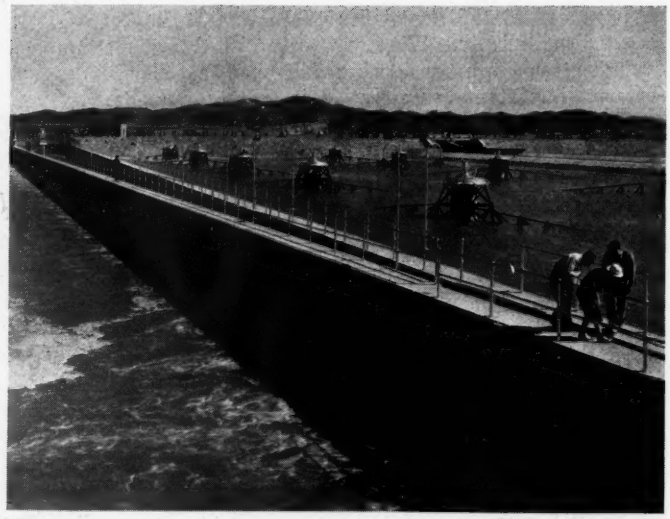
World's Largest Conveyor Belt

MEASURING 9700 ft. long, a conveyor belt installed for construction work at Grand Coulee Dam is approximately twice the length of the longest conveyor belt ever employed and is a product of the Mechanical Goods Division of the Goodyear Tire & Rubber Co., Akron, Ohio. Of 48-in. width and eight-ply construction, this belt was manufactured in eight separate pieces weighing 10 t. each. During installation the sections were vulcanized into one continuous endless belt weighing 80 t. The completed belt required 30 t. of cotton and 50 t. of rubber for its manufacture. Moving at a speed of 450 ft. per min., the belt will carry the stone for an 11-min. ride, approximately one mile from source to damsite destination, providing a flow of 2000 t. per hr. of aggregate required by the contractors for the project.

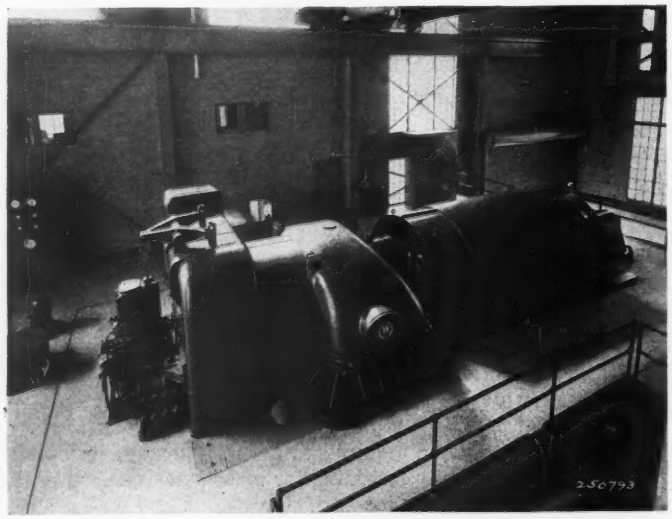
In summer, when bearing friction is at minimum, approximately 90 hp. are required to put the empty belt in motion. Once the belt is fully loaded approximately 50 hp. are required to hold it back to the desired speed of 450 ft. per min., as the installation is what is known as a "downhill" job. In winter, approximately 125 hp. will be required to start the belt when empty. 50 hp. will be required to keep it moving, instead of being used as a retarding force as is the case in summer operation.

PICTURES of Engineering

Another great Federal reclamation project goes into action. The photograph at the left was taken on October 18 at the dedication of Imperial Dam, when Secretary of the Interior Ickes pushed the buttons which lifted the headgates on the California side of the Dam and started the operation of the desilting works for the All American Canal. The Secretary and his party here face the Colorado River above the Dam. The canal will be 80 miles long.



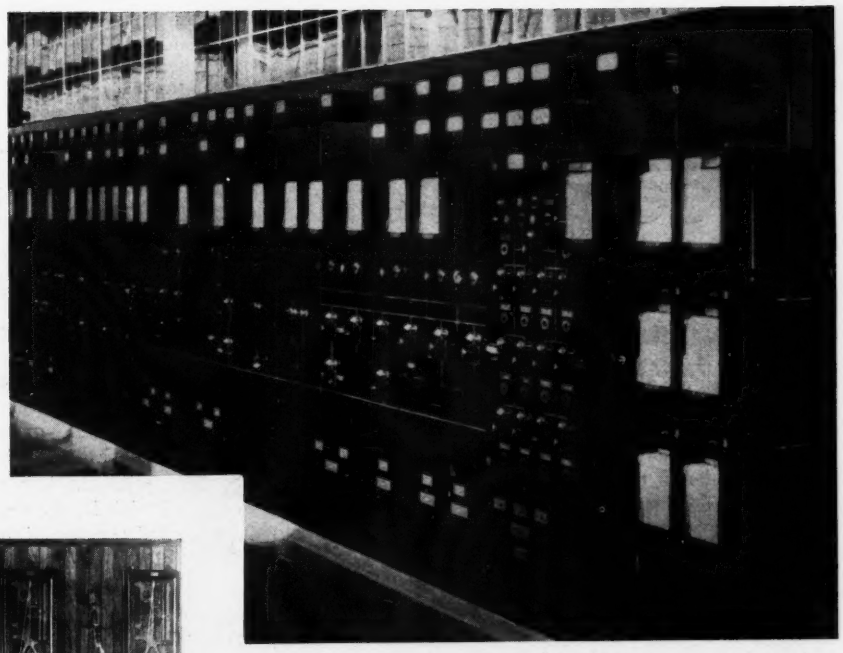
The All American Canal was built by the Bureau of Reclamation to take the place of a canal which looped through Mexico. Built at a cost of $30,000,000 this project will assure an adequate water supply to a million acres of rich land in the Imperial and Coachella Valleys. At the right is shown a view of the desilting basin where the water is cleared of its great burden of silt. Only the tops of the Dorr clarifiers are seen here. Their job is to draw the mud towards their centers to be piped back to the river below the dam.

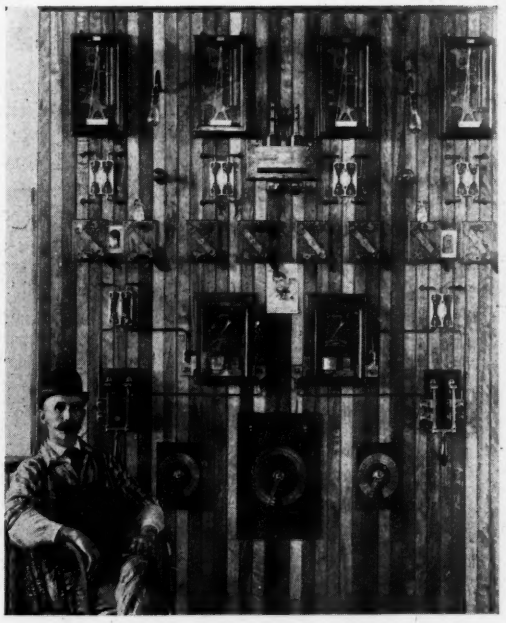


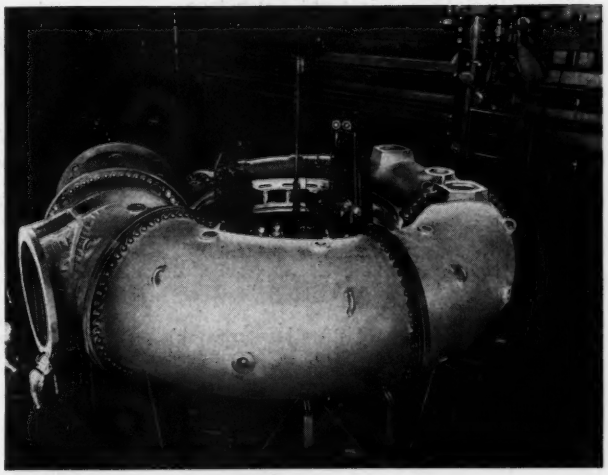
Superheated steam, so hot that it turns steel cherry red, drives the new 26,000 hp. turbine generator of the Kansas Gas & Electric Co., at Wichita, Kan. Built by the Westinghouse Electric & Mfg. Co., this new unit will assure the system an adequate supply of energy to meet all emergencies. It operates at 3600 r.p.m. and the initial steam temperature is 825 deg. F. The rotor shaft was made in one piece from a pressed and forged steel ingot, then bored through from end to end. After reaming and polishing, the hole through the shaft was examined with a magnifying periscope, guarding against imperfections. The unit is installed in the Kansas Gas and Electric Company's recently completed station on the little Arkansas River just north of Wichita.

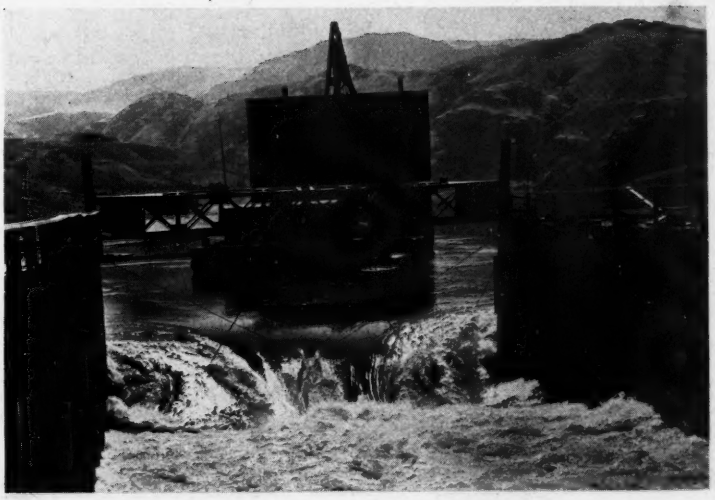
Interest

Switchboards old and new. Progress in electrical design is disclosed in a startling manner in the comparison of two switchboards—the modern Westinghouse unit shown at the right, and the pre-historic contraption of 50 years ago shown below. Note the iron hat and the swell handle-bar moustache of the operator in attendance.









The super doughnut shown above is the casing for one of six giant hydraulic turbines recently installed at Boulder Dam. This is one of two under construction at the Allis-Chalmers Mfg. Co. in Milwaukee. These units, rated at 115,000 hp. apiece, are the largest ever built.

At the left is shown an interesting view of the closing of one of the 70 ton steel gates which will block this diversion slot of Grand Coulee Dam. Closer and closer it floats toward the opening and when it is finally in place the swift water of the Columbia will flow through this portion of the dam no more and the slot itself will be filled with concrete. Photo by the Bureau of Reclamation.

Industrial Plant Modernization

Mac Sim Bar Paper Co., of Otsego, Mich., removes old boiler and installs new 100,000 lb. per hr. unit fired by an underfeed stoker.

IN THIS DAY of high pressures, when special designs and 1,000,000 lb. boilers are so much in the limelight, it is well to remember that back of the fanflare and pageantry the older, tried and proven smaller sized, lower pressure equipment is doing the bulk of the world's work. This does not mean that high pressure and temperature do not have a definite place, but it does mean that standard moderate pressure equipment adequately meets the need of the average plant. By taking advantage of modern practice, particularly in water wall and furnace design, high efficiency, capacity and reliability may be obtained in a design particularly adapted to the specific needs of a given plant.

An excellent example of this is the modernized boiler room installation of the Mac Sim Bar Paper Co. at Otsego, Mich. Here a vertical fire tube boiler was removed and a new Springfield cross drum boiler fired by Westinghouse underfeed stoker installed as the first step in a far sighted rehabilitation program to bring the power plant facilities in line with present needs. The company generates all electric power with two back pressure turbine units. The new boiler is designed for 300 lb. w.s.p., but is operated at present at 210 lb. ga., 100 deg. F. superheat. The size of the new boiler was limited by building steelwork to a furnace width of 16 ft. and the unit as installed has a maximum continuous steaming capacity of 130,000 lb. per hr.

The boiler proper contains 9220 sq. ft. of heating surface with the lower tubes staggered to form a slag screen. The side and rear furnace walls are water cooled by 3 in., O.D. bare tubes placed on 3 9/16 in. centers, with the lower section along the clinker line covered with Drake cast iron blocks. Bigelow-Liptak suspended construction is used on the front and upper side walls. The furnace volume is about 4250 cu. ft. and the water wall tubes add some 1585 sq. ft. of steam making surface. Water wall headers are connected to the drum by downcomers and risers on the outside of the steel encased setting. These are grouped and enclosed by removable sheet iron coverings, as shown by Fig. 2.

The boiler is baffled for three passes with a Foster-Wheeler superheater, designed to give 100 deg. F. superheat, located between the first and second pass. A flue over the top of the boiler connects with a separate 6336 sq. ft. Foster Wheeler economizer.

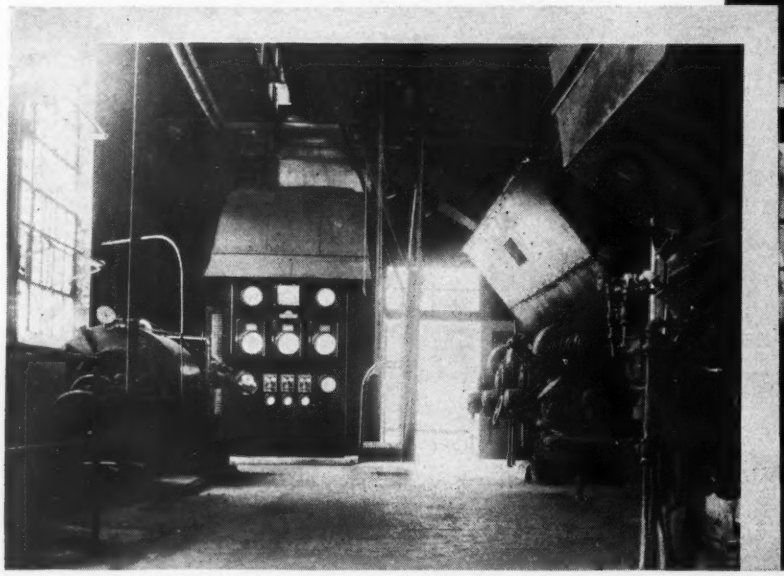


Fig. 1. Below. General view of the firing aisle showing the front of the new boiler, the control panel, weigh larry and forced draft fan

Fig. 2. (Right) The boiler setting is steel encased and the water wall downcomers and risers have removable sheet iron casings to protect the insulation

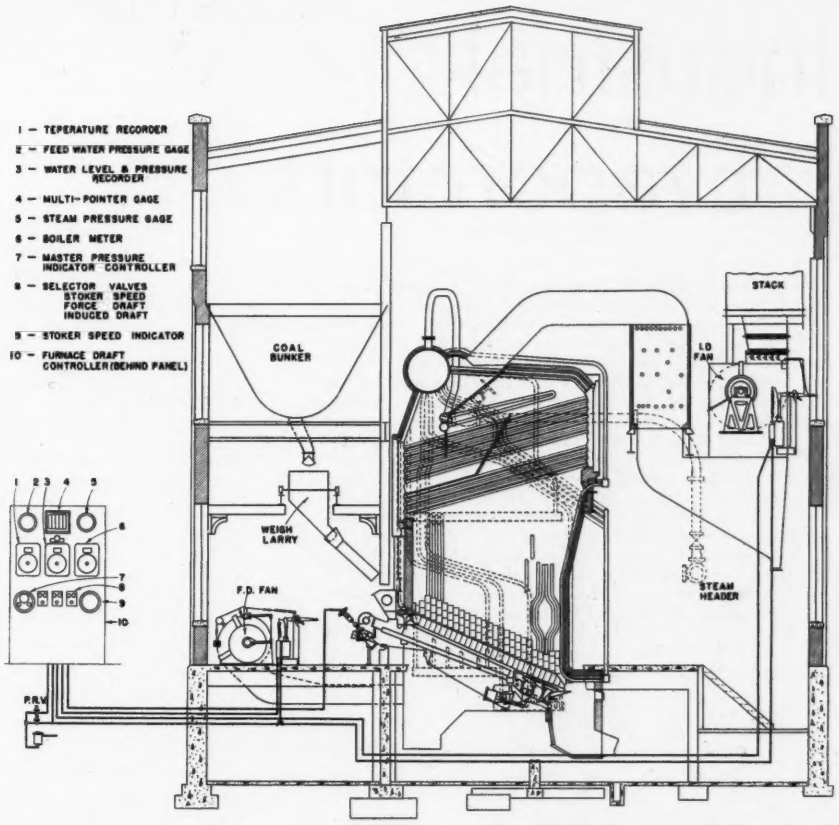


Fig. 3. Actual cross section of the boiler and boiler room with a diagrammatic arrangement of the combustion control system

From this the gases flow downward through a siftings hopper, where they make a right angle turn upward to the induced draft fan. This hopper is emptied through a drop pipe which extends down to the basement, where it terminates in a hood placed at such a height that a push cart fits under it conveniently. From under the hood a suction line leads back to the induced draft fan. This simple arrangement is effective in preventing dust while the hopper is being unloaded. Under normal load conditions of 100,000 lb. per hr. the economizer reduces the gas temperature from 650 to 400 deg. F. and increases the water temprature from 205 to 300 deg. F.

Induced draft is furnished by a Clarage fan driven by an Elliott geared turbine. The fan is supported on steelwork at the same level as the economizer, and although provision was made to add a concrete base slab later if found necessary, the steel support has proven entirely adequate and there is no tendency to vibrate. The fan discharges vertically to the base of a short 8 ft. dia. steel stack, 50 ft. high.

Coal running around 13,800 B.t.u. per lb. is burned on a Westinghouse nine retort link grate underfeed stoker having 200 sq. ft. of projected grate area. The forced draft fan, also a Clarage, is driven by an Elliott turbine. It is installed on the boiler room floor directly in front of the stoker, as shown by Fig. 1. Coal is supplied to the stoker hopper from an overhead bunker, through a Bartlett & Snow 2-ton traveling weigh larry.

Complete Bailey automatic control, including feedwater regulation, is installed, arranged as shown diagrammatically by Fig. 3. This is centralized on a Bailey boiler panel, which in addition to the combustion controls proper has steam pressure and multipointer draft gages, a boiler meter, steam temperature recorder and combined water level and steam pressure recorder. Other boiler accessories include: Reliance neon illuminated water column, Vulcan soot blowers, Beaumont ash gates, Edward blowoff and feed valves, Crane stop and check valves, and Crosby safety valves. Boiler feed makeup is taken from the well water system, treated in a Scaife cold process lime and soda softener with Nalco after treatment in the boiler drum. Boiler feed is heated in an open heater, using the auxiliary exhaust steam and is pumped by a Union horizontal duplex steam pump installed in a separate pump room.

All in all, this is an excellent example of industrial plant modernization: Conservatively rated with adequate reserve capacity for emergencies; performance fully up to expectations; and well engineered in accordance with limitations set by the existing building and future requirements of the mill.

Hamilton & Weeber of Grand Rapids acted as consulting engineers. C. F. Sisson, assistant manager of the Mac Sim Bar Paper Co., was in charge of the installation; C. L. Miller is chief engineer of the power plant and Carl Arenhoevel is boiler room foreman. The unusual name of the company, formed in 1903, was coined from the first syllable of the names of the three founders: M. B. MacClellan, S. W. Simpson and G. E. Bardeen.

Industrial Evaporators

Early in 1935 the Firestone Tire & Rubber Co. put into service a high pressure plant incorporating evaporators for supplying process steam. Earlier studies had indicated that, with the turbine exhausting direct to the process mains, a boiler pressure of about 900 lb. was desirable. Makeup would have approximated 80 per cent, however, and total solids, mostly sodium chloride, in the raw water supply were high. Limited water treatment experience available at that time for the 800 to 1400 lb. range, combined with the desirability of close control of non-condensable gas and carry-over to the turbine, led to the decision to use the boiler in a closed system with evaporated makeup. This necessitated raising the boiler pressure and supplying the process steam from industrial evaporators or, as they are sometimes called, heat transformers. From a background of several years operating experience, the author discussed the design, operation and application of equipment of this kind before the Fall Meeting of the A.S.M.E. Portions of the paper appearing below deal primarily with maintenance and tests of the evaporators.

By W. K. ADKINS

Firestone Tire & Rubber Co.,
Akron, Ohio.

INDUSTRIAL PLANTS which require both steam and power for their various processes, and, where those requirements are in the proper ratio, can effect large economies by the installation of high-pressure boilers and bleeder or back-pressure turbines. There is no set rule by which the proper pressure can be determined, because each installation will depend upon local conditions and requirements. The water supply, the pressure and quality of the process steam, determine, to a large extent, the selection of equipment.

Studies for the Firestone installation indicated that the largest returns on the investment could be obtained from a boiler having a pressure of around 900 lb. per sq. in. provided the turbine exhausted directly into the process-steam main; whereas, if the turbine were exhausted into an evaporator system the optimum boiler pressure would necessarily be around 1300 lb. per sq. in. All calculations were based upon a maximum steam temperature of 750 deg. F.

Table I. Representative Analysis of Evaporator Feed and Concentrate

	Evaporator feedwater	Evaporator concentrate
$NaOH$, ppm	13.7	253
Na_2CO_3, ppm	38.0	109
Na_2SO_4, ppm	171.0	1490
$NaCl$, ppm	132.0	1150
$CaCO_3$, ppm	5.1	...
Na_3PO_4, ppm	...	83
Silica, ppm	9.9	50
Alumina, ppm	1.8	10
Oil	...	Trace
Total solids, ppm	344.0	...
Total dissolved solids, ppm	...	3360

Each of the five evaporators eventually installed contains 4320 sq. ft. of effective coil surface and is designed for an operating heat transfer of 475 B.t.u. per sq. ft. per hr. per deg. F. temperature difference, or, from 640 to 680 B.t.u. with perfectly clean tubes. From tests, which were conducted after 3 yr. of operation, it will be seen from the present heat-transfer rate that the evaporator coils have remained free from scale deposit. The tests were conducted with the continuous-blowdown valves closed. It was also necessary to carry a higher vapor pressure during this period; hence, the test data will not be in exact agreement with the values shown on the diagram, Fig. 1.

Considerable difficulty has been experienced with scale formation in the feedwater heater because of its relatively high operating temperature. A number of chemicals have been used to prevent scale deposit in this exchanger, none of which has been entirely satisfactory. Shortly after the unit was placed in operation it was found necessary to install a by-pass around the feedwater heater so that it could be cleaned during operation. The heat transfer in the evaporator coils now, under normal conditions, is such that full load can be handled with the feedwater heater cut out of the system. This is possible because of the fact that the evaporator feedwater is conditioned to prevent scale formation, rather than to use raw water and depend upon cracking for scale removal.

Some scale is formed in the evaporator drip cooler and make-up condenser, which necessitates periodical mechanical cleaning. During the summer months, the cleaning periods are as long as 3 mo. apart. More frequent cleanings are required during cold weather, because with cold water the chemical reactions in the

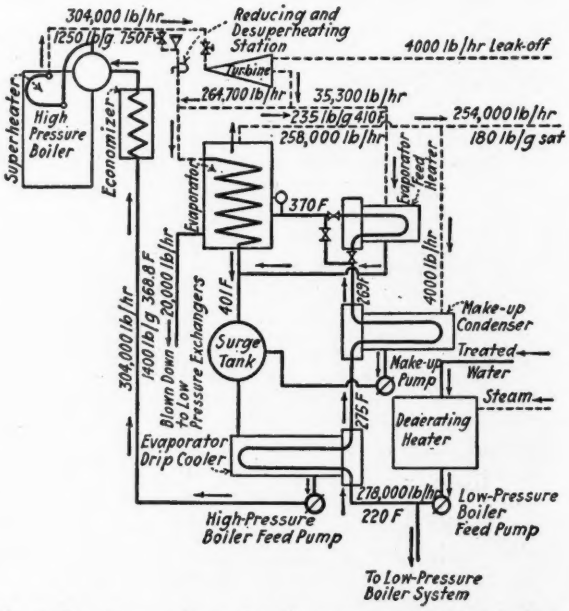


Fig. 1. Flow diagram showing how the evaporators fit into the closed circuit of the high pressure boiler. Exhaust from the turbines at from 235 to 250 lb. ga. (400-430 deg. F.) is split between the evaporator and evaporator feed heater. Both drain to the surge tank and then through a drip cooler, to prevent flashing, to the boiler feed pumps. The evaporator feedwater condenses from 10 to 12 per cent of the turbine exhaust

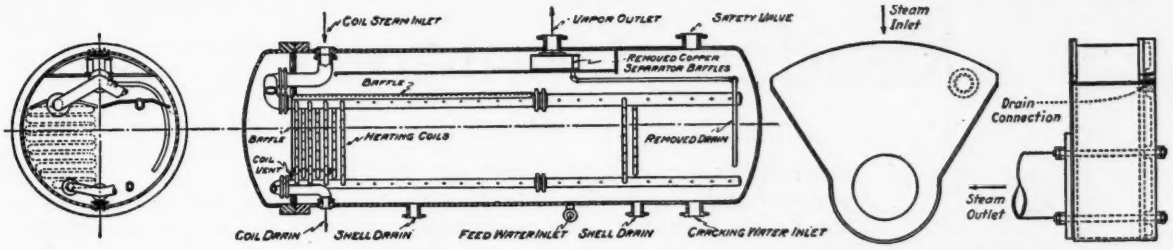


Fig. 2. Five all-welded single-effect evaporators of this kind are installed in the plant. Each has 340 coils, made of 1 in. O.D., 18 B.w.g. arsenical copper tubes, totaling 4320 sq. ft. of surface. The shell is 108 in. in diam., 28 ft. 8½ in. long, giving a disengaging area of 260 sq. ft. The two elevations on the right show the details of the last stage separator which was changed to reduce the pressure drop and moisture in the vapor

softening plant are not as complete as they are when warm water is used.

Evaporator feedwater is treated in a cold-process batch softener using lime, soda ash, sodium aluminate, and ferric sulphate. It is then heated to a temperature of 220 to 225 deg. F. in a deaerating heater. After the heater, a tannin compound is added before the water enters the heat-exchanger system. Before using the tannin compound it was frequently necessary to clean the evaporator drip cooler and make-up condenser every week. The final water conditioning takes place in the evaporator shells where phosphate is delivered direct to maintain an excess of 30 to 50 p.p.m. With this method of water conditioning, it is necessary to crack the evaporators only four to six times a year to remove a very thin eggshell-like deposit. A representative water analyses, is shown by Table I, Continuous blowdown is used to control the concentration of the evaporator brine.

Table II. Evaporator Performance as Determined from Recent Tests

1	Test number	1	2
2	Duration of test, hr	1	2
3	Number of evaporators	5	5
4	Average water level above evaporator center line, in.	9	8
5	Average feedwater to evaporator, lb per hr.	254000	256000
6	Average steam from high-pressure boiler, lb per hr.	295000	297000
7	Average steam to evaporator coils (estimated), lb per hr.	291000	257000
8	High-pressure boiler-drum pressure, lb per sq in.	1290	1290
9	Temperature of steam leaving superheater of boiler, F.	746	745
10	Average exhaust pressure, back-pressure at turbine, lb per sq in.	246	244
11	Average temperature, at back-pressure turbine exhaust, F.	426	425
12	Average evaporator-coil pressure, lb per sq in.	244	241
13	Corresponding saturated steam temperature, F.	404	403
14	Average vapor pressure in main line, lb per sq in.	188	188
15	Average evaporator-shell pressure, lb per sq in.	199	200
16	Corresponding saturated-steam temperature, F.	387.4	387.8
17	Corresponding heat in vapor, Btu per lb.	1198.6	1198.6
18	Corresponding heat in water entering evaporator, Btu per lb.	238.7	348.0
19	Temperature of feedwater entering drip cooler, F.	224	224
20	Temperature of feedwater entering make-up condenser, F.	259	261
21	Temperature of feedwater entering feed heater, F.	270	270
22	Temperature of feedwater entering evaporators, F.	270*	375
23	Temperature difference, coil to shell, (Item 13—Item 16), F.	16.6	15.2
24	Temperature difference, coil to shell, with approximate correction for superheat in steam to coils and feedwater temperatures below saturated-steam temperatures, F.	24.2	17.0
25	Heat transfer, Btu per sq ft per deg F per hr, using item 23.	680	661
26	Heat transfer, Btu per sq ft per deg F per hr, using item 24.	455	591
27	Total solids in evaporators at start, ppm.	1700	2060
28	Total solids in evaporators at end, ppm.	1925	2500
29	Average solids in feedwater to evaporators, ppm.	173	170
30	pH of vapor ranges from	5.9 to 6.2	
31	Total solids in steam (by conductivity and with no correction for CO_2), ppm.	4.5 to 5.1	

* Evaporator feedwater heater out of service.

Steam Quality

Figure 2 shows the section and end view of one of the evaporators. To provide for moisture elimination, a vertical baffle was installed at the head end, running from the bottom of the shell to a point near the top of the tube bundle, where it joins a horizontal baffle which extends halfway to the rear head and lies about 12 in. above the water surface. Above the first baffle, a second horizontal baffle is installed from a point near the front head, extending to the rear, beyond the vapor outlet, where it is closed off. The final vapor separator consists of several rows of vertical V-shaped baffles through which the vapor is passed before leaving the evaporator shells.

This gill-type separator is drained into a false bottom, details of which are shown at the right hand side of Fig. 2. A 2-in. submerged drain was originally installed, terminating near the bottom of the evaporators. During the early stages of operation, considerable difficulty was experienced with moisture in the vapor. A number of tests showed the quality of the vapor to be 90 to 93 per cent. The pressure drop through the last-stage separator also caused trouble. At full load, a maximum differential of 30 lb. per sq. in. between the shell and vapor main was noted. It was found, upon examination, that the vertical baffles in the last-stage separator were badly distorted and they were removed. This step reduced the pressure drop to normal and reduced the moisture content in the vapor slightly. The internal drainpipe was next removed, which resulted in a remarkable improvement, bringing the vapor quality up to an average of 99.6 per cent.

In conclusion, it is believed that evaporators have a very definite place in industrial installations, particularly, where high-pressure installations are used to produce both power and steam and the feedwater contains a large amount of impurities.

Readers' Conference

These pages are open to readers for the presentation or discussion of any timely power plant topic. The Editors invite your participation.

Industrial Overhead Line Maintenance

THE PROBLEM of overhead line maintenance is somewhat different in an industrial plant than in a public utility. In the latter case a great number of customers are connected to the lines and if something goes wrong a large number of people are affected. In an industrial plant maintenance can, in most cases, be done while the lines are cut off. By the use of proper sectionalizing switches at strategic points it is possible to cut off sections so that the whole plant need not be shut down. For instance, in one plant manufacturing clay products, the layout naturally divides the various sections into two parts, one laying to the east and the other to the west of the point where the plant is fed with 2300-v. three phase current. The line feeding the two main branches is protected by an oil circuit breaker with overload relays and an automatic reclosing device. This prevents any shut down caused by lightning surge or by a momentary overload on the system. The breaker closes, and then if the trouble is still present, it will open again. This takes place three times and then stays open unless the fault has been cleared. After the third opening the breaker has to be reclosed manually. The main oil breaker is located in a substation which also feeds other circuits. The line then goes overhead. On the first pole on each of the overhead branches mentioned a pole top oil switch is located. As the main switch in the substation is not always available to the plant electrician, the sectionalizing switches can be used whenever it is necessary to cut off either east or west branch, and the other branch can remain in operation. These poles are stepped from the ground as they are not readily accessible to the ordinary person.

In speaking of stepped poles, the general policy of this company is to provide steps on all poles upon which transformers or fused cutouts are used. This not only saves time when it is necessary to go up the pole but is also a safety measure. Many of the poles are located at readily accessible places and therefore the steps are not started near the ground, but about 12 ft. above it. This prevents any unauthorized person from using them. The electrical service truck used by the electrician is of the delivery type with a flat roof. This makes an excellent platform to work from in case the cutouts are at a height which is suitable. It also makes an excellent starting place to get on the steps where the mountings are higher. One might say that this puts too much dependence upon the truck which might happen to break down at a critical time. In case of a truck breakdown a short ladder can be used or hooks, and in several years the truck has not failed to be on hand during an emergency.

With a properly laid out transmission system within the plant, enough sectionalizing switches to provide adequate protection for the maintenance crew, and with steps on all poles which have apparatus mounted on them, the electrician can replace fuses, fix overhead lights, or do any of the numerous jobs in a minimum of time and with little outside help.

Sayreville, N. J. K. B. HUMPHREY

Plate Key-Pullers

MANY TYPES of modern, medium weight and heavy machinery such as mills calenders, etc., are driven by an overhung gear keyed to a shaft end. The job of drawing one of these keys, can at times, upset the whole schedule of repairs, simply because the key has become so wedged or corroded into place that its removal requires hours instead of minutes.

To expedite the removal of such keys, several plate key-pullers should be used, each capable of taking a certain range of sizes. In our plant we have used such plates to pull keys ranging from ½ in. x ½ in. x 6 in. up to 2 in. x 2 in. x 18 in., and with their aid we have started keys that until then seemed immovable.

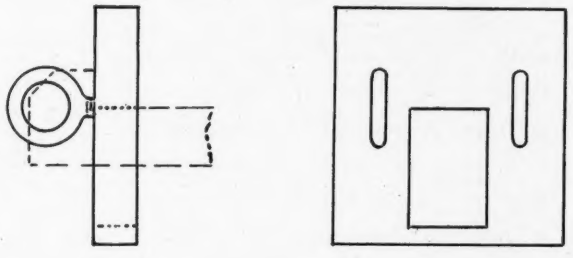


FIG. 1

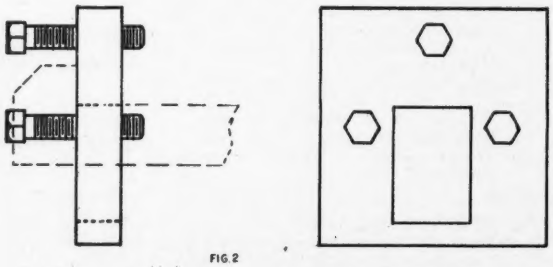


FIG. 2

Fig. 1. Puller for starting obstinate keys of large size
Fig. 2. Puller designed for keys of small size

The main member of each puller is the plate, the size and thickness of which must vary with the size of the key and the amount of expected strain. When in doubt it is best to make it overly strong, rather than to make a flimsy affair that will bend when put to work.

For large keys, torch out or cut out a rectangular hole as shown in the sketch (Fig. 1). The dimensions of this cut-out must be such that the whole head of the key will slip through easily. On each side of the cut, and in line with the bearing edge of the hole, drill and tap out two holes, and into these insert two sturdy eye or ring-bolts, again governing the size of these by the scope of the work to be done. The puller is then complete and ready to be used with the addition of a chain and a toe-jack.

In practice the puller is dropped over the head of the key, and the pulling edge set into place under the key-head extension. The chain is then run through the two eye-bolts, and over the toe of the jack. When the jack is extended, the key will start! A twenty-five ton jack and a plate 1½ in. thick will pull a 2 in. key when all other means have failed.

For small keys it is not necessary to make the rig so elaborate. The same sort of plate will serve, but instead of eye-bolts, chain and jack, three set-screws may be placed as shown in Fig. 2. After setting the plate, turning down evenly on these three screws will draw the key.

If such pullers are to be used regularly in a plant all keys must set so that the heads project enough to allow the insertion of the plate. Also the keys must be kept in good condition so that the head extension makes a true angle of 90 degrees with the body.

Providence, R. I. JAMES P. MARSHALL.

Philosophies of a Licensed Operator

MR. DABLEMONT'S article, "Licensed Operating Engineers," in the September issue of POWER PLANT ENGINEERING, made interesting but sad reading. Mr. Dablemont states in part that the basis of all engineering is mathematics, physics, chemistry, mechanics, and common sense, with which I heartily agree; but from the rest of the article, I am forced to believe that Mr. Dablemont became hopelessly confused when the Examining Board reversed his order of the basic subjects and started with the last subject first.

Keeping ambitious young men, both with and without sheepskins, who have specialized along some one or two lines of engineering from self-destruction, and making practical engineers of them is one of the toughest jobs the engineer has to handle. It is, also, one for which he receives nothing but condemnation and abuse from the very ones who will benefit most. This holds true whether on the Examining Board or operating a plant.

The above problem, when coupled with the fact that these young men are sometimes ill-advised by some master mechanic or plant chief who received his training out of the community in which he now holds his responsible position, and who has been unsuccessful in convincing the Board of Examining Engineers that he should be given an operating license, which he does not need, without the regular examination, becomes a problem of enormous scope.

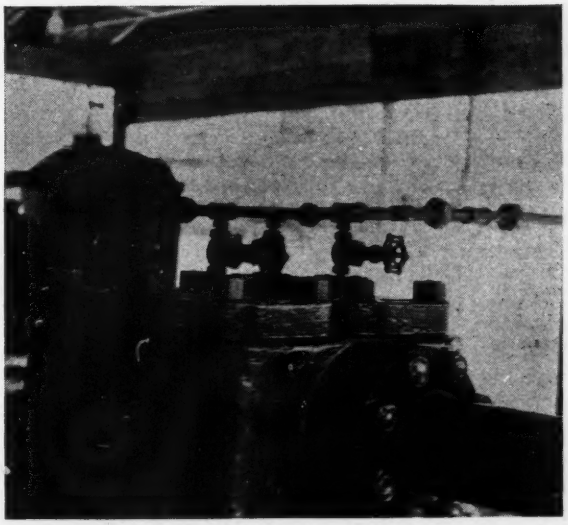
This, along with other engineering subjects that come up from time to time, seems to point to a national examining board composed of practical operating engineers, whether they be college trained or not.

St. Louis, Mo. F. B. PATTON, Cor. Secy. National Association of Power Engineers No. 2 of Missouri.

Bleeders Eliminate Pump Pound

WHEN working against pressures up to 800 lb. per sq. in., and handling crude petroleum with a gravity range of 38-43 Deg. Bé, a pipe line pump station was troubled with severe pounding of the pumps. The vibration on the line, resulted in frequent leaks and in one instance the fracture of the pump base.

Bleeding the pumps at the outlets formed in the castings cut down the pounding temporarily but it reappeared shortly after the valves were closed and regular deliveries resumed. Since the relief afforded by opening the bleeders indicated gas or air pockets, one pump was equipped experimentally with bleeder valves installed over each valve through holes drilled and tapped into the valve covers themselves. By hooking the individual valve cap bleeders into a manifold with a union on each branch, the task of removing a valve cap for servicing requires only the breaking of the union involved in addition to the usual removal of retainer nuts.



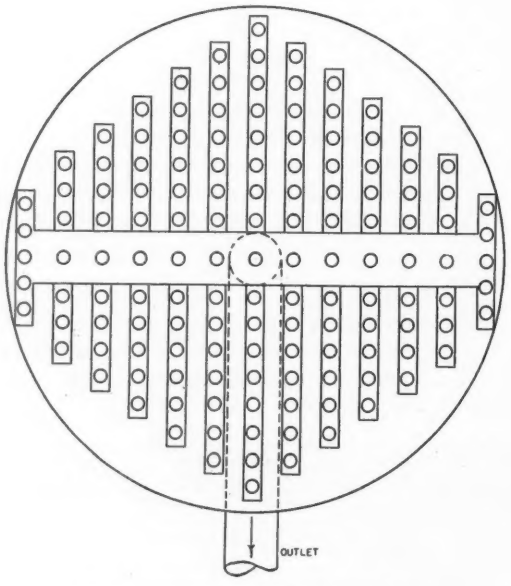
Screwed into holes tapped in the valve cover castings, this individual bleeder system gave complete clearance of gas or air lock which caused pounding of the pump

When using the valve cap bleeders it has been found necessary only to establish full discharge chambers by operating with the valves cracked until the pump stream is uniform, after which the bleeders may be kept closed until valve rap or pump pound again indicates air or gas lock. In this case frequently the operation of only the bleeder over the source of the noise affords immediate relief.

Longview, Tex. ELTON STERRETT.

Water Outlets from Filter Beds

WE HAVE two 10,000 gal. rapid rate softeners with green sand beds. The raw water passes from the top of the tank through the sand bed and gravel into the water tanks and lines. It was found impossible to backwash or regenerate these softeners without causing a great deal of the sand to pass into the system and tanks. After replacing these beds several times, one softener was taken out of service and all mineral and gravel removed. At the bottom of these tanks there is a cast-iron header from which pipes branch out as shown in diagram. All drilled openings faced upward to the gravel bed.



Pipe arrangement in bottom of softener

Upon a close examination a great many of these openings were found to be plugged with small pieces of gravel so in order to prevent this from happening again, all the openings were turned to discharge downward against the bottom of the tank. After the gravel and sand beds were replaced it was found that the backwash valves and regenerating values could be opened wide and no sand was washed out. This idea of turning the discharge of the pipes away from the gravel beds has solved our problem and reduced the recharging time to one-half the original time. We now have fixed both softeners in this manner and have not had any sand trouble.

Los Angeles, Calif. GEORGE O. WHEATLY.

Trade or Profession

I HOLD a professional license in two states, and have had a little experience with the drafting of licensing laws. I am also familiar with the work of the professional engineers' societies, in spite of which, I am somewhat at a loss to answer the question "Is engineering a trade or profession?"

Fifty years ago it was fairly easy to define the term "Professional man," it was applied almost exclusively to those engaged in the independent practice of some branch of activity which required special education and training, principally of course, law, medicine and the church. There were also such fields as engineering, teaching and accounting which were sometimes classed as professions more or less as a matter of courtesy.

Irrespective of any definitions contained in the dictionary, how shall we now define the term profession? If our definition is to be based upon educational standards, business and manufacturing are now so highly developed that in order to become fully qualified in any branch of them it is necessary to gain a considerable degree of general and specialized education and experience. So if educational qualifications are to be our guide we may as well admit the fact that the lines of demarcation between professors and businesses have been to a large extent eliminated. The banker, the accountant, and often the salesman consider that they are as truly professional men as the engineer, and who shall say that they are not? Not I, at any rate, provided of course, that they live up to the best emphasis placed upon the personal responsibility and independence of the professional man, and this is where traditions of their calling.

If we go back to the older ideas, we find great we come slam up against a blank wall when we attempt to apply this test to the majority of present day engineers. Probably ninety per cent of them are employees of industrial or public service organizations, and the amount of personal responsibility and independence which they are allowed, is neither more nor less than that permitted by their employing companies, whose senior executives are as a rule, not engineers.

Then too, in all probability, most of the other white collar members of the organization consider that they are just as much professional men as the engineers, and whether they are or not, it is very unlikely that the executives will encourage the engineers to get "High Hat" about their job. As a matter of fact accounting, salesmanship, and other branches of the company's activities often offer a more promising path to high executive position than does engineering.

In view of the above conditions what attitude should we take?

From personal experience, I have come to the conclusion that with the exception of those comparatively few engineers who are engaged in private practice, there are just two roads open to us. Either to stop talking so much about our professional standing and admit that any man who is honorably and efficiently engaged in work which requires education and experience for its proper performance is just as much a professional man as we are, or to go "Trade Union" to the extent of advocating the obtaining of professional licenses by all those qualified, and to use the power of professional organizations to obtain the best possible terms of employment and official standing for our members.

The first alternative is, in my opinion, the more truly ethical, and the second better business, provided of course, that we can get away with it.

Bloomfield, N. J. JAMES O. G. GIBBONS.

Metal Raceway for Power Plant Wiring

DURING the installation of a new steam generator in our power plant it was necessary to run some new lighting circuits and reroute some of the old circuits. A new panel board using circuit breakers instead of fuses was installed with the object of providing greater reliability of service.

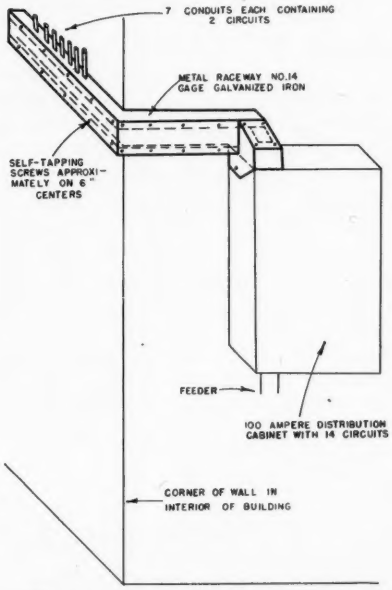

7 CONDUITS EACH CONTAINING 2 CIRCUITS
METAL RACEWAY NO.14 GAGE GALVANIZED IRON
SELF-TAPPING SCREWS APPROXIMATELY ON 6" CENTERS
FEEDER
100 AMPERE DISTRIBUTION CABINET WITH 14 CIRCUITS
CORNER OF WALL IN INTERIOR OF BUILDING

Diagram showing use of metal raceway for rerouting circuits around corner

The new board contained 14 circuits with 2 spares and the circuits were so grouped that two could be placed in each outgoing conduit. This meant that 7 out-going conduits would leave the board. Due to the boiler position the board was around an interior corner of the building and the metal raceway shown in the attached sketch was used for part of the circuit. The raceway was ordered from a local sheet metal shop who fabricated it for a very nominal charge.

A great deal of saving in labor and material was obtained, for many conduit fittings were avoided and pulling in of wires was much easier. Also the installation is much more accessible than conventional construction and will be much easier to perform maintenance on.

Hibbing, Minn. A. L. BENNETT.

Power Plants On Postage Stamps

A NEW ISSUE, not more than two months past, released by the Republic of Chile, S. A., pictures a power plant on a 50 Centavos postage stamp and is dedicated to the mining industry of Chile.

The plant that is pictured on the stamp is that of the Andes Copper Mining Co. at Barquito Chanaral, Chile, S. A. This plant has a total capacity of 30,000 kw. and operates at 400 lb. per sq. in. steam pressure. Situated at the foot of the Andes coastal range of mountains on the bay at Chanaral, this plant furnishes the power to run the mines at Potrerillos, Chile, 92 mi. into the interior at the 10,000 ft. elevation. Power is generated at 6900 v. and sent out at 88,000 v., stepping it down to 2300 v. for use in the mine. The plant is 12 yr. old and is the second largest in Chile.

Barquito, Chanaral, Chile. JOHN J. MASTERSON.

License Laws

I AM familiar with a boiler house in a plant where large quantities of steam are used for industrial purposes. This steam plant is in a state which has no license laws. I would like to add to what has already been said by Mr. Frederickson and Mr. Lane on the subject of license laws, hoping the persistent efforts by the many groups endeavoring to obtain protective legislation will be aided by the discussions found on these pages.

When a water tender is needed in this boiler house a man is taken out of the labor gang and is broken in by another water tender. After breaking in for a few days, learning how to perform minor operations, he tends water alone, nothing being told him of the various types of boilers, how they are put together, nothing of the dangers which may arise from improper firing or the failure to keep sufficient water in the boiler. Later on he may be given a few boilers of a different type in another part of the plant to operate by himself. He breaks in for one day on these boilers and he is an engineer. The chief engineer as he is called does not examine this new engineer in any way to find out if he is at all competent. These boilers have often been subjected to severe strains. The operating engineer is sometimes instructed when a boiler is taken off the line to open all doors (there being about 16 on each boiler), and pop the steam off (operation is at 260 lb.) to cool the boiler off. Almost every time before these boilers are put back on the line the drums require calking in places. Caustic embrittlement may cause a failure in the future because they are calked on the outside. The superheater tubes began leaking where they enter the header so they were welded, which in my opinion is not good practice.

Recently it was called to my attention that a man who had only one day's breaking in was put in charge of these boilers. This was one year after he had broken in as he was to be the relief engineer in case of sickness. His first turn on these boilers was the night shift and if conditions out of the ordinary occurred he said he would have to let them take care of themselves or run up and get the engineer in the main boiler house. In the meantime there could be every chance of a disastrous explosion with the result of the destruction of life and property by which the chief engineer could be found guilty because he willfully and purposely permitted these boilers to be operated by an incompetent engineer.

There is not one man in the entire boiler house department who can set the valves on a pump or engine. A man is called in from another department when any adjustments or repairs are needed. Recently two piston rings broke in a small duplex pump, the entire personnel was at a loss as to what the trouble was until the repair man was called in and disassembled the pump.

I believe the management of any industry large or small should strive for the education of its operators in the safe, efficient and economical operation of its power plant. The waste of fuel by incompetent engineers is enormous. The interest of every conscientious engineer should be the conservation of our natural resources. Elimination of waste, uninterrupted service, maximum

safety and efficient operation by an engineer with a combination of technical and practical knowledge of steam engineering is essential to the operation of any steam plant.

The majority of boiler failures are due to improper operation. For the protection of both the public and the reputation of the competent engineers the only adequate protection, is strict license regulations, which will eliminate at least the greatest number of incompetent operators from the field.

Engineers are not made by the license, but license by the engineer.

Fort Thomas, Ky. WALTER J. HARVEY.

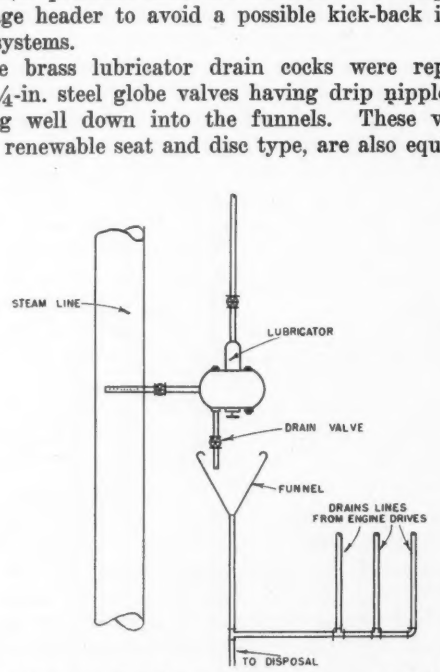
Preventing Injuries When Draining Lubricators

SCALDS and burns, experienced while draining, cleaning, and refilling hydrostatic lubricators are often responsible for a high minor injury rate in power plants. In the majority of instances these accidents are caused by the crystalization and breakage of brass plugs and drain cocks, leaking valves in the steam lines of the lubricator or the practice of draining hot condensate and residual oil into receptacles held in the operator's hand. The liability of injury from any one of these causes increases with the steam pressure.

In one large industrial power plant injuries from locomotive type lubricators supplying oil to high pressure engines were substantially reduced by installing permanent drainage systems, as shown in the sketch. Funnels sufficiently large to receive the hot waste from all drainage openings are placed directly under the lubricator, and are piped to a disposal point. To avoid duplication of piping, all open engine drains connect to these lines. Throttle valve, cylinder cock, and other pressure lines are connected to a separate drainage header to avoid a possible kick-back in the open systems.

The brass lubricator drain cocks were replaced with ¼-in. steel globe valves having drip nipples extending well down into the funnels. These valves, of the renewable seat and disc type, are also equipped with extension stems so that the operator's hand is sufficiently far away from the funnel to avoid any possibility of burns from leakage or flash steam. Injury hazards and maintenance costs are further reduced by substituting stainless steel plugs and fittings for the brass lubricator parts subjected to high temperatures.

Roanoke, Va. S. W. COLEMAN.



Drainage system installed on locomotive type lubricators

"Giddap" Entropy

IN THE NOVEMBER issue of POWER PLANT ENGINEERING there appears an article by A. Bement which was written with the commendable object of removing the scientific voodooism that surrounds some of the most common quantities of everyday engineering. I heartily approve of this attitude; but I feel that it is not exactly fair for one man to tell another that all one has to do to become an equestrian is to climb on a horse and say, "Giddap". The horse might have different ideas on the subject.

Thus Mr. Bement "defines" entropy as the total heat divided by the total temperature, which I do not find very difficult or mysterious; but when I see an expression something like

$$\emptyset = c_v \log T + \frac{R}{m} \log v + \text{a constant}$$

I begin to feel that the horse has taken the bit in his teeth, and is starting to run away.

Entropy is a very complicated quantity, and it is by no means easy to handle. Its absolute value, for entropy does have an absolute value, is one of the most complex determinations of higher thermodynamics. Thus, to define it arbitrarily, as Mr. Bement does, and dismiss it lightly, only serves to muddle more thoroughly an already completely muddled subject.

At the outset, it should be understood that a knowledge of what entropy is, is not at all essential to an understanding of its properties, or to the ability to make use of it in thermodynamical computations. To this day, no one knows exactly what gravitation is, and yet for more than two centuries men have understood and practicably applied Newton's Laws. I would therefore recommend, that, unless a man has an unusually good mathematical and physical background, in addition to a burning thirst for more or less obscure scientific conceptions, he forget entirely about what entropy is, and confine himself to become familiar with what it does and how it is used.

The first law of thermodynamics states that a change in the energy of any system must be accompanied by work done on or by the system and either an absorption or a rejection of heat by the system. A little thought will show that this is merely a statement of the fact that the total available energy of the universe is always the same. This law is very useful; but while it does tell us that heat and work are mutually convertible, it says nothing at all about the direction in which such conversions take place. For such information, we must turn to the second law.

This law may be most simply stated by saying that heat cannot flow from a body of lower temperature to a body of higher temperature *without leaving some permanent change in an external body.* To say that heat

cannot flow from a cold body to a hot body of its own accord, is a truism. It is the fact that some compensation must be made for this reversal of the natural order that is important. Take, for instance, Mr. Bement's example of refrigerating processes. Heat undoubtedly flows from the cold compartment to the much warmer ambient air. If we trace this process back to its ultimate source, we find that the electricity used to run the refrigerating machinery came from the local utility; the electricity was produced by steam passing through a turbo-generator; and the steam was produced by burning fuel in a furnace. Now the electricity has been converted into the useful work of refrigeration, the exhaust steam may be pumped back into the boiler and returned to its original state, but the fuel burned has undergone a permanent change which can never be restored.

Mr. Bement further points out that there is enough heat in the outdoor air in winter to melt a large quantity of iron. This is quite true. If all the heat in the atmosphere and the oceans could be concentrated and made available for use, the world's problem of cheap and unlimited power would be solved for all time to come. But unfortunately this heat is not available. It has been, so to speak, *degraded.* Entropy is a measure of this degradation of heat; the higher the entropy, the greater the state of degradation. Now while entropy is a measure of the degradation of heat in the same manner in which a watch is a measure of time, it must not be assumed that degraded heat is entropy, any more than your alarm clock is identical with time.

This leads us to the principle of perpetual motion of the second kind. Nobody today believes that it is possible to build a machine which once set in motion will continue to run forever. This is perpetual motion of the first kind, which is a direct contradiction of the first law of thermodynamics, i.e., the principle of conservation of energy. Perpetual motion of the second kind, while not quite so fantastic, is just as impossible. Reduced to its lowest terms, this kind of perpetual motion is typified by a machine which will operate on a complete cycle, and do nothing except produce useful work and cool a heat reservoir. This would mean, for example, that the heat rejected from the cold compartment of the refrigerator mentioned previously, could be used to operate a heat engine. This would not mean that work could be obtained without any expenditure of energy, but it would be the most economically efficient machine on the face of the earth. But the entropy of the air has been increased to such a point that the heat is no longer available.

Thus the second law of thermodynamics indicates the direction in which any change of the energy state of a given system must take place. This law has been stated by Max Planck as: "Every physical or chemical process in nature takes place in such a way as to increase the sum of the entropies of all the bodies taking any part in the process".

The foregoing has been quite general and perhaps somewhat abstract, so that it is now in order to discuss some of the practical uses to which this conception of entropy may be put. In the first place, it is the *change* in the entropy of a body which is more important than the entropy itself. The change in the entropy of a substance in passing from one state to another is equivalent to the accompanying change in heat content divided by the absolute temperature of the substance. This is just about the same thing as Mr. Bement said in his article, but it should be kept in mind that this condition holds true only for infinitesimal changes unless the absolute temperature remains constant. Thus, under the horizontal portions of the curve in the original article, this determination of the change in entropy would apply, but under the other sections of the curve the determination would be only roughly approximate. So the best way to find the change in entropy of a substance in passing from one state to another is to look it up in table, and not try to compute it.

The equation given in an earlier section of the text, is Clausius' original defining temperature of entropy. Note that a defining equation is not a definition. The equation merely states what the quantity is equivalent to, and not what it is. An inspection of this equation will show that the entropy of a substance depends upon only the temperature and the volume. As both these variables are mutually independent, and may be varied at pleasure without respect to each other, the entropy of a substance depends only upon the initial and final states of the substance, and is in no way concerned about the method in which the substance reached the final state from the initial. This is not the case with all other quantities. The process by which a substance changes its state would make a tremendous difference in the quantity of heat absorbed or rejected.

This independence of entropy on the process employed, makes it useful in defining the state of a substance. Thus if we know the entropy of a pound of steam, we need know only one additional fact, either the pressure, the specific volume, or the temperature, to completely determine the state of the steam. From this information we can readily construct a temperature—entropy diagram. This type of diagram is very useful in power plant problems, because the area enclosed by any cycle drawn upon it is the heat absorbed or rejected during the cycle, and the ratio of this area to the area under the curve is the thermal efficiency of the cycle.

This discussion certainly does not simplify the subject of entropy to any considerable degree, but I hope that it will warn our imaginary horseman to grip with his knees, and firmly grasp the bridle before he digs in the spurs.

Long Island City, N. Y. GEORGE P. RETTIG.

Removing Gears, Wheels, Couplings, Etc., From Shafts

WHEN a gear, wheel, coupling or other attachment is to be removed from a shaft, the precaution should be taken to see whether or not there are any set screws binding the part against the shaft. Check whether or not there are set screws at more than one place in the part. Set screws are often placed at two places. Also, remove all visible set screws and note whether or not there is a second set screw under the top one. This is frequently done as a means of locking the lower set screw against the shaft or against a shaft key.

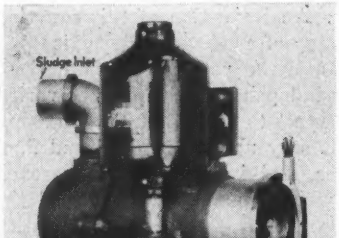
Baltimore, Md. THOMAS TRAIL.

New Equipment

Information that you desire about any equipment will be gladly furnished without obligation. WRITE POWER PLANT ENGINEERING.

Desludging Valve

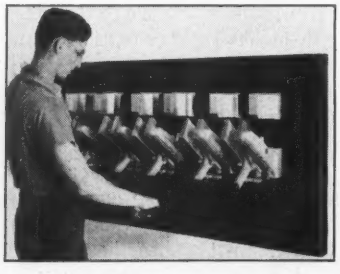
DEVELOPED as a part for its hot process lime soda water softener in which sludge must periodically be removed from a settling tank, The Permutit Co., 330 West 42nd St., New York, N. Y., has placed upon the market an automatically operating valve for permitting the flow of sludge from a container by gravity or under pressure.



Automatic operation of such a valve is highly desirable because periodic desludging by hand is apt to be overlooked or postponed for such an interval as to impair the efficiency of operation. With automatic desludging this is accomplished under precise control, assuring uniform conditions. The valve is motor operated and of simple construction.

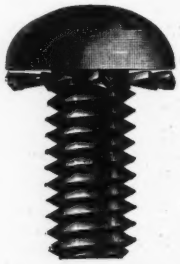
3-pole, 10,000 Amp. Disconnect

THE I-T-E CIRCUIT BREAKER CO. of Philadelphia, Pa., has recently completed a hand-operated, 3-pole, 10,000 ampere disconnected switch. This switch, as illustrated, is so constructed that all three poles are opened or closed in unison, thus constituting, in effect, the opening or closing of a 30,000 ampere, single pole switch. Contrast the ease with which this huge switch is manually operated and the effort required to operate a conventional type knife switch of ¼ the amperage. This singular engineering achievement which enables a switch of such high capacity to be operated by hand is incorporated in the patented "Klamp-Tite" feature.



Pre-Assembled Lock Washer and Screw

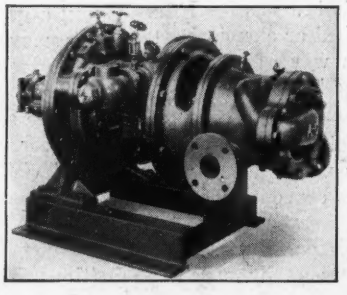
SHAKEPROOF LOCK WASHER CO., 2501 North Keeler Ave., Chicago, Ill., announces a new fastening unit known as Sems. This new fastening unit speeds up production by saving time formerly lost in putting lock washers on screws. When Sems are used, there is assurance



that no screw can be driven without a Shakeproof lock washer under the head to protect it from vibration. In addition, every screw is equipped with the correct size and type of lock washer for its particular head. Waste and loss of lock washers are eliminated because the Shakeproof lock washer cannot come off the screw in the assembly operation regardless of how it is handled.

Centrifugal Pump

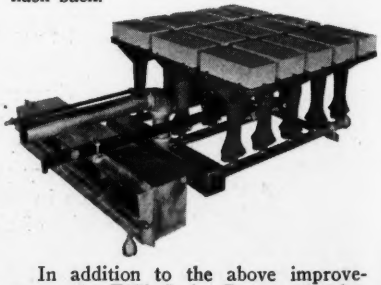
A NEW line of close coupled steam turbine centrifugal pumps, of the SSUnit type, has just been made available by the Centrifugal Pump Division of the Allis-Chalmers Mfg. Co., Norwood Works, Cincinnati, O. The new line of pumps offers the advantages of compactness and accessibility together with operating smoothness and efficiency over a wide range. Units can be obtained in single and two-stage pumps which are at present available for capacities up to 500 g.p.m. for lower heads and for lower capacities up to 500 ft. head. They have cast-iron casings with bronze impellers and are bronze fitted. These centrifugal pumps are applicable to small power plants and to auxiliary pump units in large steam plants. They are particularly suitable in industrial plants where process steam is available. In some instances compressed air can be used for driving the turbine.



Gas Burner

SUPPLEMENTING its 600 Series Gas Burner, the Webster Engineering Co., Tulsa, Okla., announces a new F600 Series Gas Burner as superior means of burning gas in metal firebox boilers. The improved venturi and greater port area

insure much higher capacities at lower pressures. At the outlet of the mixing tube unique baffles make possible even distribution of the flame around the baffle brick and as a result the maximum flame length is greatly reduced. To suit the combustion characteristics of various gases, interchangeable grills with multiple ports can be varied, proper sizing of which prevents any possibility of flash back.



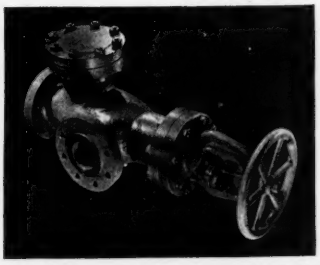
In addition to the above improvements, the F600 Series Burner also has the same features of the 600 Series Burner: Simple installation, extreme quietness of operation, flexibility to meet firebox conditions at various gas pressures, low draft loss, plain gas pilots and safety pilot.

Photo News Valve values

THE EDWARD VALVE & MFG. CO., INC. • EAST CHICAGO, INDIANA

EVERY POWER HOOK-UP CALLS FOR EDWARD VALVES

PICTURES SHOW TYPICAL EDWARD DESIGNS FOR KEY POSITIONS IN MODERN POWER GENERATING PROJECTS, AND EQUIPMENT USED TO KEEP EDWARD QUALITY UP TO PAR



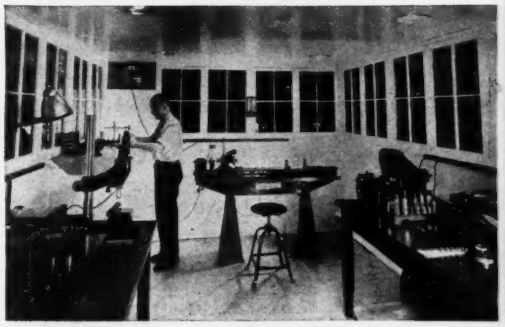
DEFINITELY UNIQUE are Edward "separated" stop-check feedline valves, for installation at the boiler drum or economizer inlet. They represent the simplest and most effective means of meeting code requirements. These two-in-one valves are built for right hand or left hand feedwater lead connection.

THIS STREAMLINE NON-RETURN valve with welding pipe ends is a good example of best current design in Edward valves. Shown is an 8″ 600 lb elbow vertical C-Mo Edward non-return valve with, of course, Edward Impactor handwheel for enhanced power in closing against test pressure and ease of operation under all circumstances. This compact model stands about four feet high and weighs close to half a ton. Seat and disk have Stellited contacts.

WELDING END BLOW-OFFS are part of an unmistakable trend in current hook-ups, which explains these 1500 lb primary rating forged steel Edward blow-off valves. Frequently Edward blow-off valve tandem combinations are welded together in Edward's modern welding department under strict laboratory oversight.

PRECISION!

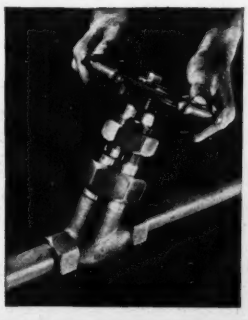
Edward shop practice begins with precision measuring, exact to the sixth decimal point. Reliable functioning of working elements of Edward valves, interchangeability of maintenance parts, positive control of operation, long life and low cost, all are related to machine shop methods. To make sure that working gages control dimensions within prescribed limits, measuring devices of almost unbelievable accuracy are needed. Edward's measuring system is founded on standard measuring blocks of accuracy of the order of 0.000004″ and measuring equipment of the order of 0.000010″.

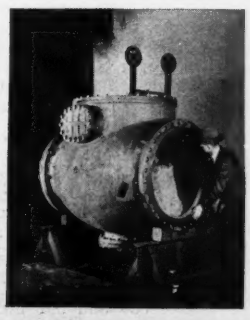


In Edward air-conditioned measuring-room (above) gages and tools are checked systematically at predetermined intervals. Master measuring machine (background), with electrically actuated pressure controlling tailstock, determines sizes up to 48″ in increments of 0.000010″. Comparator on bench at right projects greatly magnified thread contours.

Left—checking with optical flats the sphericity of relief and check valve balls by master size block and interference bands from monochromatic light source. Right—precision verification of working plug gage by use of frictionless reed-controlled light beam.

FORGED STEEL EDWARD STOP VALVES always come to mind in connection with modern power hook-ups. Edward screwed end straightway design is made up of pedigreed components, each designed and built for hard use on basis of years of field service. New lightweight malleable iron handwheel, with knobs for firm grip, facilitates operation and gives leverage for tight contact. Check valves also available.





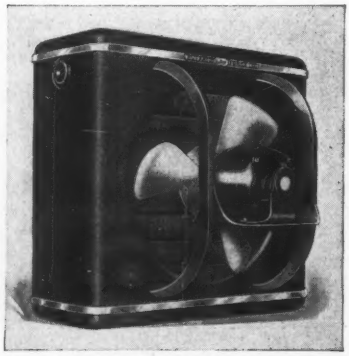
EDWARD ATMOSPHERIC RELIEF VALVES, sizes 6″ to 48″, occupy important positions in power hook-ups the country over. Generous dimensions — center to face equal to nominal pipe size — built of laboratory tested materials — design details carefully evolved through the years — present models represent revolutionary improvement. Cut shows one of four similar condenser relief valves furnished in connection with one recent steel plant modernization program. Disk is counterbalanced by weight and cable for sensitive response to pressure change. See sheaves mounted on top valve cover. Big manhole on side is for observation.

EDWARD VALVES

Stop · Check · Blow-off · Non-return · Feed Line · Relief · Bleeder Line · etc.

Unit Heaters

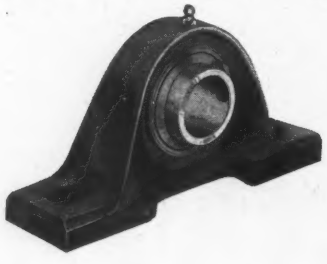
WITH the new line of Model C Breezo-Fin Unit Heaters, the Buffalo Forge Co. of Buffalo, N. Y., combines the utilitarian unit heater with streamlined appearance in demand today. Finished in dull lustre brown metallic color which resembles old hammered copper and built to blend inconspicuously with varying backgrounds, the Model C has the sleek lines of real utility with no unnecessary gadgets and no mechanical misfits to make the installation difficult. It is built in a number of sizes ranging from No. 121 for capacities of 720 c.f.m. to Model 241 for capacities of 3550 c.f.m.



The heat release ranges from 27,800 to 392,000 B.t.u. per hr., depending upon the steam pressure used. The heating element is a one piece, seamless copper tube with square copper fins. The casing is entirely new with no sharp corners and with a new rigid motor mounting which permits the use of motors of various makes. Motor vibrations are absorbed in rubber silencers and invisible threaded hangers on top of the unit make installation easy and permit quick re-location when desired. Louvers of pressed steel are curved to deflect the heated air with minimum friction. They are readily adjustable. The units can be supplied from stock with single phase, 3 phase or direct current constant speed motors. Two speed single phase and direct current motors are also available in all listed sizes.

Ball Bearing Pillow Blocks

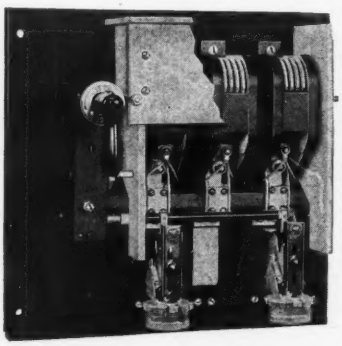
A COMPLETE new type of ball bearing pillow blocks has been developed under the trade name Sealmaster, by Stephens-Adamson Mfg. Co., Aurora, Ill. Outstanding feature of this new line is the permanent seal principle of the bearing, a positive, centrifugal sealing principle consisting of two inner and two outer steel seals. Inner seals, one at each side of bearing, are pressed into the outer ring and become permanent parts of bearing, forming a tight grease chamber for race grooves and rolling elements. External flinger seals are pressed into position and external seals are lined with felt applied with cellulose cement. Felt liners of external seals travel in labyrinth angular grooves of inner seals.



Air Circuit Breaker

A NEW AIR CIRCUIT BREAKER for the protection of power and lighting circuits with an interrupting rating of 10,000 amp. is announced by the General Electric Co., Designated Type AE-1A, the new device is available in the ratings 600 v. a-c; 250 v. d-c; 15-225 amp. The breaker is completely enclosed in a steel housing and may be installed conveniently and operated safely.

One of the features of the new breaker is a system of arc quenchers and barriers which prevent arcs from occurring between the contacts and the steel enclosing cover. The arcs are extinguished in less than fifteen thousandths of a second after the contacts part.

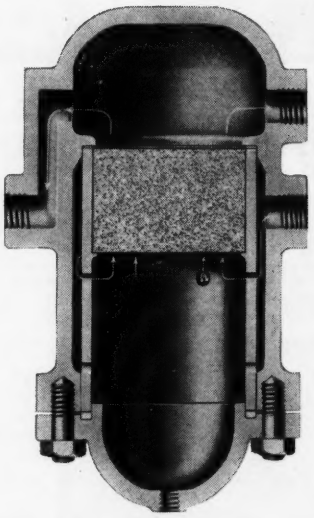


The AE-1A breaker is offered in single, double, triple, and four pole units. Manual or electrical operation, for live-front and dead-front switchboard mounting, or metal enclosures with or without pull-boxes for individual mounting is optional. Mechanism of the breaker is trip-free and it cannot be held closed with the handle against short circuits. Red and green targets on the front of the enclosure tell whether the breaker is closed or open.

The new breaker has dual magnetic over-current devices, although dual magnetic-thermal devices can be substituted without additional cost. Both devices can be applied for motor running protection, provided the starting characteristics of the motor are such that the breaker will not trip during the temporary overload while the motor starts.

Air and Gas Filter

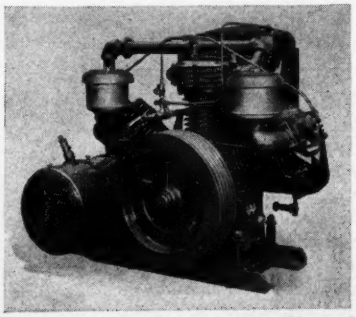
NEW FILTERS, designed to meet the increasing demand for a highly efficient filtering device in gas and air lines, have been developed by the Fisher Governor Co., Marshalltown, Ia. These new Fisher Types 360 and 361 filters remove foreign matter and separate free moisture from the air and gas pipe lines with a minimum friction loss. The especially manufactured filter element is both acid and heat resisting, and unusually strong, utilizing extremely hard alumnium oxide



crystals bonded together. Gases pass through this porous filter with only slight loss due to friction. Installed in either vertical or horizontal pipe lines with standard pipe fittings, the filters are unusually compact. Their advanced design separates free moisture before gases pass through the element. This reduces the load, and results in longer service life and less frequent cleaning. Flanged and bolted bottom castings permit easy, quick removal for cleaning. These filters with screwed connections are available in sizes ¼ in. to 1¼ in. inclusive, and with flanged connections from 1½ to 2 in.

Air Compressor

WORTHINGTON PUMP AND MACHINERY CORP., Harrison, N. J., has developed a portable air compressor with power take-off drive. Consisting essentially of a Worthington compressor driven through a Worthington Multi-V-Drive by a Hercules drive unit installed between the truck transmission and the front universal joint of the propeller shaft, the new unit combines maximum portability with utilization of a minimum of truck pay-load



space. The compressor is the three-cylinder two-stage radial air-cooled type used on the standard Worthington portable mountings, and includes many modern features of construction: the improved Feather Valve, ring-type fins, large sectional type intercooler, articulated connecting rods, force-feed lubrication, and by-pass unloading.

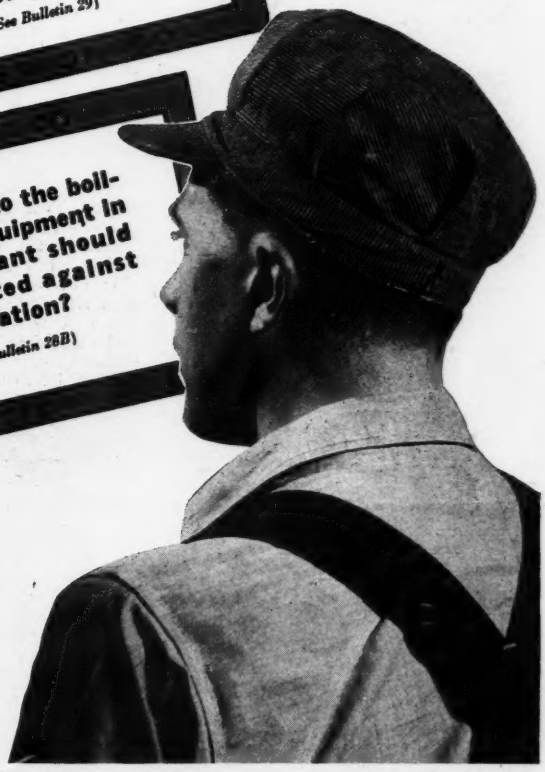
DO YOU KNOW?

How should an engineer go about making a rapid check test of hardness in boiler feedwater?
(See Bulletin 6A)

What simple method is available to reduce the dosage of alum required to clarify water used in beverages, swimming pools, ice plants, etc.?
(See Bulletin 29)

How can an engineer increase the efficiency of an existing Lime and Soda Ash Softening Plant?
(See Bulletin "Nalco System for Softening Plants.")

In addition to the boilers, what equipment in a power plant should be protected against scale formation?
(See Bulletin 28B)



YOU can find the answers to these and numerous other interesting questions in Nalco educational bulletins on water treating and related subjects which we offer to send to any reader without obligation. Get your copies now. Please specify the ones desired. We will also be glad to answer questions along the same lines pertaining to your own plant. For lower costs and better performance, use the Nalco System of Feedwater Treatment. NATIONAL ALUMINATE CORPORATION, 6224 W. 66th Place, Chicago, Ill.

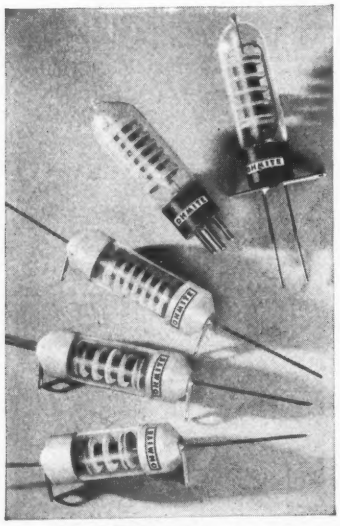
PARTIAL LIST OF BULLETINS:
No. 6-A: "Standard Methods of Water Analysis and Interpretation of Results." "Nalco AB System". "Nalco System for Softening Plants." No. 21-B: "Control of Boiler Blowdown." No. 28-B: "Anti-incrustants for Use in Feed Lines, etc." No. 29: "Clarification of Water." "Nalco Water Testing Equipment Catalog."

ANY WATER NALCO SYSTEM ANY

Inquiries other than domestic, *except those from U. S. Possessions, Canada and Mexico*, should be addressed to ALFLOC LTD., Bush House, Aldwych, London, W. C. 2, Eng. Canadian inquiries should be sent to ALUMINATE CHEMICALS LTD., 372 Bay St., Toronto, Ont.

Hermetically-Sealed Precision Resistors

To PROVIDE the fullest protection against extreme heat, humidity, salt air, sulphur fumes and other severe atmospheric conditions in industrial, coastal, marine and tropical locations—and to insure sustained accuracy noise-free performance, trouble-free life in the most exacting applications, Ohmite Mfg. Co., 4835 Flournoy St., Chicago, Ill., makes available the first commercial series of hermetically glass sealed precision resistors.



The new Ohmite precision units are non-inductively pie-wound on porcelain in 2, 4, 6 or 8 sections, and enclosed in strong hermetically-sealed glass tubes with the terminals emerging through vacuum-type glass seals. They are provided with soldering lugs and wire terminals or with bakelite tube base for mounting in tube-type sockets.

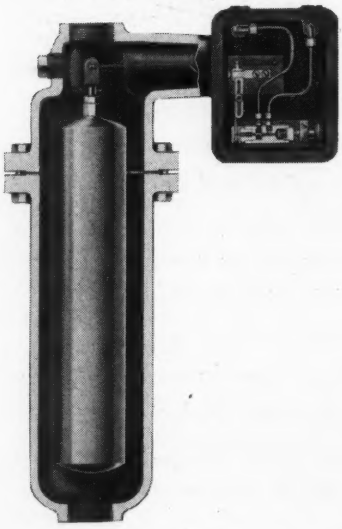
Sectional Small-Parts Bin

A NEAT, compact and efficient means for keeping track of screws, bolts, nuts, washers, rivets, staples, pins, brads, fuses, contact points, gaskets, shims, packing and the innumerable small parts required in the servicing of all kinds of mechanical equipment is provided by Add-A-Bin, introduced by the Noggle Products Co., Ann Arbor, Michigan.

This is a system of unit bins obtainable separately and assembled by the user to fit his individual needs. The bin housing may be screwed to a wall, bench or cupboard, or to a panel which may be fashioned into a portable kit. A bin may be opened for removal of a single item and it is so balanced that the weight of its contents causes it to close automatically when the mechanic's hand is removed. If, when open, the bin is lifted slightly, it will lock open. Or it may be lifted higher, pulled out and down and remains open horizontally for cleaning. Or it may be removed entirely from the housing. Some mechanics mount Add-A-Bin assemblies on either side of a vertical board, provide it with a wood base and a handle and they have a parts kit which they take to the job just as they do a tool kit.

Liquid Lever Controller

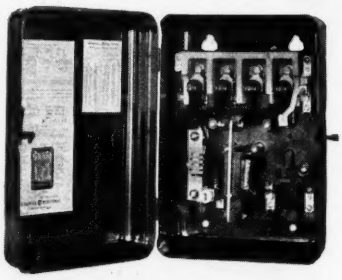
A NEW long range liquid level controller, Type 246 Level-Trol, has been developed by the Fisher Governor Co., Marshalltown, Iowa. This new control, which can be used on liquids of all specific gravities, is especially suited for high viscosity oils, because its float operates without guides, eliminating friction and sluggish operation. The Level-Trol delivers operating medium pressures of 2 to 15 lb. to the diaphragm valve. An anchored cantilever spring supports the



float, which is specially weighted to sink in the liquid being handled. As the liquid rises, that displaced by the float creates a buoyancy which partially relieves the cantilever spring. As the spring returns toward its normal position, this action is transmitted to the pilot valve by an arm that contacts the spring through an extremely small rotary stem. Fisher engineers state that a level change as small as $\frac{1}{32}$ in. will register a pressure change at the diaphragm. The Fisher Level-Trol is available in two sizes. One with a 14 in. adjustable level change; the other with a 32 in. adjustable level change.

New Starter for Single-Phase Motors

A NEW MAGNETIC switch has been announced by General Electric's Industrial Department for use with single-phase motors. The new device, which is available in ratings of 3 hp. at 110 v., 5 hp. at 220 v., and 7½ hp. at 440 v.,

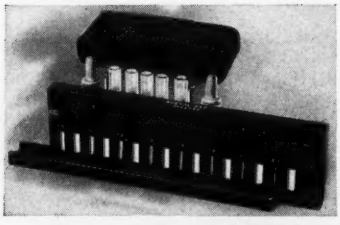


consists of a standard general-purpose 4-pole magnetic switch with two poles connected in parallel. This arrangement makes the device equivalent to a 2-pole switch with one overload relay. Its application is limited to use with single-phase motors whose normal full-load current does not exceed 30 amp.

pH Slide Comparator

A NEW Slide Comparator for the colorimetric determination of pH, chlorine and phosphates has been developed by W. A. Taylor & Co., 872 Linden Ave., Baltimore, Md. The new outfit is molded entirely from plastic. All pH, chlorine and phosphate values, as well as the indicator names, are engraved in white directly on the plastic slides. Improved catches are used to hold the top on the base and all metal parts are rustproof. The whole outfit, including the slide is 10 in. long, 2⅛ in. wide and 4 in. high and weighs only 1½ lb.

The new comparator consists of a slide and a base. Each slide contains nine color standards alternating with ampoules of distilled water. All color standards are guaranteed by the manufacturer to maintain their accuracy for a period of 5 yr.



The base contains two vials of indicator solution, with 0.5cc pipettes, five 5cc test tubes, and a piece of etched glass in a special compartment. Determinations are made by filling three of the test tubes with the test sample, adding 0.5cc of indicator solution to the middle one, placing the slide on the base and moving it back and forth until the test sample matches one of the color standards. The pH, chlorine or phosphate value is then read off directly from the values on the slide. One base can be used with any number of color standards.

COMPLETE
STEEL VALVE LINES
FOR MODERN POWER PLANTS

150 to 1500 lb. SP

Gate - Globe
Check - Non-return
and Blow-off

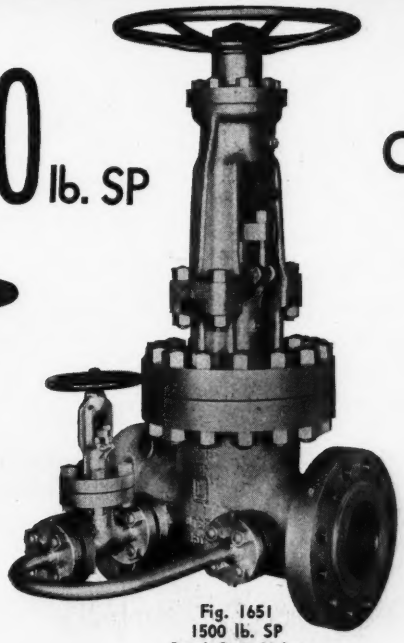


Fig. 1651
1500 lb. SP
Steel Gate Valve
with By-pass

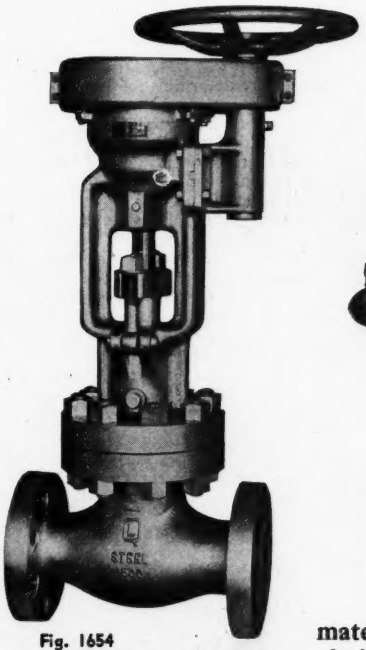


Fig. 1654
1500 lb. SP
Steel Globe Valve
with Gearing

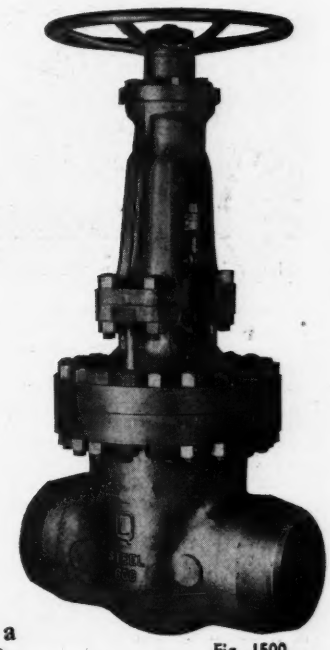


Fig. 1500
600 lb. SP
Steel Gate Valve
with Welding Ends

Lunkenheimer Steel Valves are designed in a variety of types and sizes and for all prevailing pressures and temperatures required by Modern Power Plants.

As no one combination of materials is suitable for all conditions, a choice of materials as well as types is available. Bodies and bonnets may be made of carbon or alloy steels, and trimmings of various alloys selected to suit the installation. Valves may be constructed for flanged or welded piping and equipped with motor control or gearing.

See our exhibit at the
POWER SHOW – Booth No. 52

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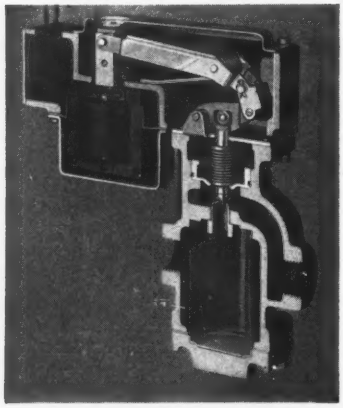
BOILER MOUNTINGS
LUNKENHEIMER VALVES
LUBRICATING DEVICES

15—67E—44

Electric Valve

AN INTERESTING departure from the conventional design of solenoid valves is found in the new electrically operated valve recently announced by McDonnell & Miller, Wrigley Bldg., Chicago, Ill. This design was developed to insure tight closure against water or fluid pressure up to 150 lb. In accomplishing this, the weight of the solenoid armature is not depended upon to hold the valve closed. Instead, it is tightly seated by a spring-loaded leverage system. The long lever being connected to the armature of the solenoid, giving the solenoid sufficient mechanical advantage for positive opening of the valve.



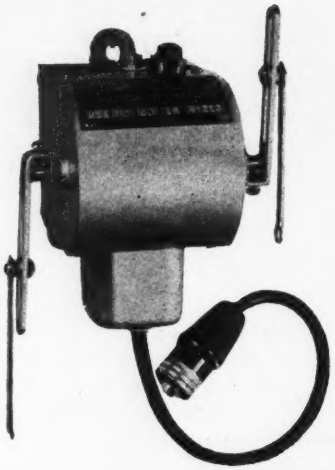
The valve and seat are stainless steel of file hardness and all packing is eliminated. An unusual feature of the valve is the slot-and-roller construction which removes all angular stress from the valve stem and assures straight thrust of the cone when seating. Discharge capacity ranges from 1100 to 3200 lb. (of water) per hr. depending of course on differential between inlet and discharge pressures. Standard electrical rating is 115-v., 60 cycle, but coils for other voltages and frequencies are available.

Air Valve

A SIMPLE air valve just announced by The Roto Co., 133 Sussex Ave., Newark, N. J., saves considerable time and labor by making it possible for one man to operate a tube cleaner entirely by himself. The new valve may be attached to any make tube cleaner for straight or curved tubes 2 in. or larger. It is placed immediately behind the motor so that the operator himself can turn on and shut off the air. It passes through the tube easily because its diameter is smaller than the cleaner, but the diameter of its air passage is equal to that of the hose. A quarter turn of the handle either way instantly shuts off the air. The valve cannot close while the cleaner is inside the tube.

Motor Operator

THE NEW Motor Operator or Damper Motor, made by Julien P. Friez & Sons (a Division of the Bendix Aviation Corp.), Baltimore, Md., is employed to give effect to the automatic control provided by thermostats, aquastats, pressurestats, furnacestats, humidistats and similar sensitive instruments themselves without recourse to electrical relays. The Motor Operator is used on low voltage which is furnished to the control circuit and the motor by the secondary of a simple transformer which is supplied with each Motor Operator from 110 v. or 220 v., A.C., supply lines, according to specifications.

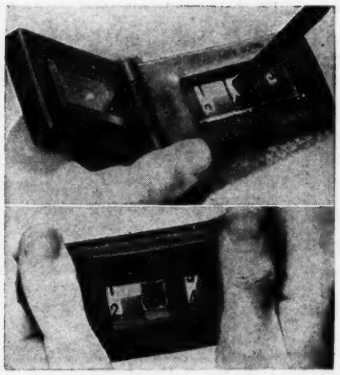


These devices are provided with auxiliary hand switches giving manual "on", "off", or "automatic" positions and, also, with arms which are adjustable in position and which are in turn connected to the draft damper of coal-fired furnaces or boilers, to the duct dampers of air conditioners or warm air systems, to zone dampers, by-pass dampers of conditioners, etc.

Many types are available for 3-wire or 2-wire applications and with built-in or separately mounted transformers. Various accessory arrangements are also included in different types according to the application.

Oil Tester

A NEW pocket device called the Lub-rim-eter, designed to determine oil contamination in the engine crankcase by 3 simple tests has recently been developed by Inspection Machinery Co. of 5511 Euclid Ave., Cleveland, Ohio.

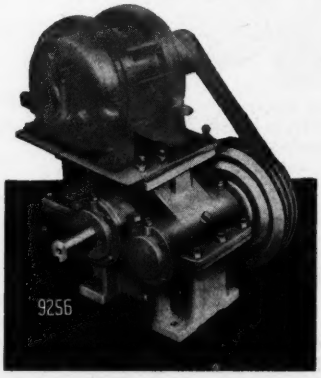


Lub-rim-eter is constructed of a pair of resilient odorless neoprene frames, holding an optical system in such a manner that a film of used oil 0.009 in. thick can be compared with four photographic standards to determine the relative amount of opaque contamination in the oil. Sample is prepared by touching the oil gage bayonet to a central groove of the Lub-rim-eter supplying the 6 to 10 drops of oil sufficient for the test.

Abrasive content and lubricity value of the oil is determined by rubbing the two lenses together, yet another test and an important one is the viscosity-piston seal test made by sealing the two glasses together by the surface tension of the oil under test and pulling them apart. A chart is supplied to interpret the results of the three tests. Lub-rim-eter can be used to advantage by fleet owners and Diesel operators to determine oil and filter practice, according to the company.

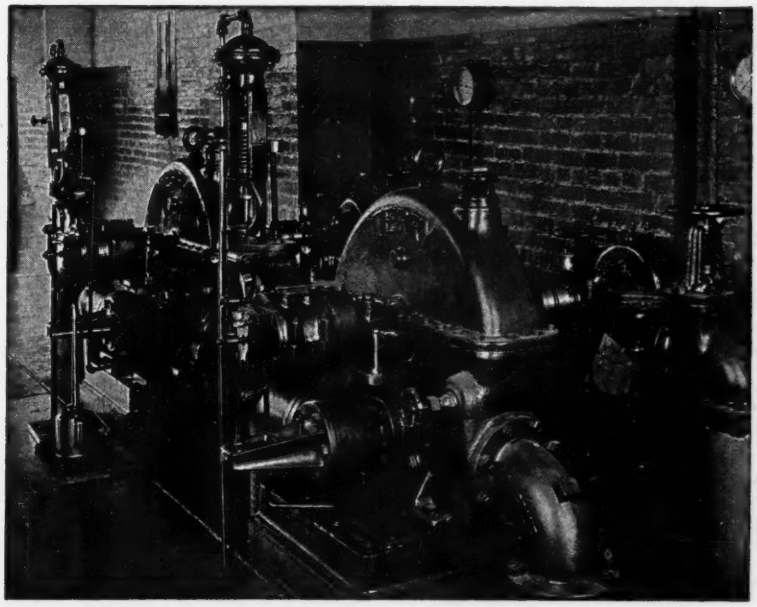
Speed Reducers

STEPHENSON-ADAMSON MFG. CO., Aurora, Ill., has added to its line of J. F. S. variable speed reducers, a new line of constant speed reducers. Saco speed reducers, having an efficiency from 89 to 93 per cent, can be used with any



standard, full speed motor to give required output speed from 13.2 to 172 r.p.m. The motor support is adjustable for V-belt drive, permitting sheaves to be replaced with ease to suit changes in required output speed. The shaft support construction permits heavy over-hung load. All shafts are mounted in precision ball bearings and the precision cut helical steel gears operate in a constant bath of oil.

TERRY



"A STRAIGHT TWO YEARS WITHOUT STOPPING"

— Thus writes Mr. Joseph J. Wernette, Superintendent of the Grand Rapids, Michigan, Municipal Power Plant, in referring to one of the 40 HP Terry Wheel Turbines illustrated above.

He states further: "The turbine is still running very well. There is no indication so far that we will ever have to stop it. It certainly is making a record."

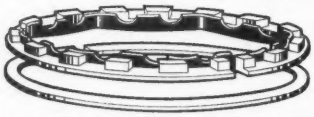
Remarks like this from Terry Turbine users are not uncommon. The simple and durable construction of Terry Wheel Turbines makes for long life and low maintenance costs. They are fully described in our Bulletin S-116. A request on your business letterhead will bring a copy.

T-1129

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD, CONN.

Piston Ring

THE HOLLAND PISTON RING CO., Holland, Mich., announces a new Segment Ring under the trade name Cast-Vent. It has only one steel segment, which is on top of a deeply cut away cast spacer.



This design avoids forming an oil trap by the elimination of the lower land and facilitates the returning of oil through the holes under the ring to the interior of the piston and then to the crank case. Both segments are expanded by a well ventilated inner ring.

Better Insulation for Wires and Cables

SIMPLEX WIRE & CABLE CO., of Cambridge, Mass., offers a new rubber insulation for wires and cables called Simplex-Anhydrex AA-LL. To their 60 per cent, deproteinized rubber insulation known as ANHYDREX AA has been added the properties of modern long life or superaging insulations. The result is a combination for the first time in one 60 per cent rubber insulation of low water absorption, high electrical qualities, long life and heat resistance. Simplex-Anhydrex AA-LL is a heat resistant insulation suitable for submarine service, it is a submarine insulation suitable for high temperature service. Neither combination has been available before in one 60 per cent rubber insulation. It also has longer physical life insulation. It also has longer physical life than any submarine rubber insulation previously available. Tests and specifications are covered in detail by a recently issued data sheet.

Chain Drive for Grain Elevator

IN THE UPDIKE GRAIN ELEVATOR, Council Bluffs, Iowa, is a Morse silent chain installation, made at an original cost of $7200 21 yr. ago, which is now being completely reconditioned at a cost of approximately $2000. There are 42 drives all told, totalling approximately 1500 hp., on elevator legs, countershafts, belt and screw conveyors, shovel drives and cooler fans. On seven 100-hp. drives on shipping and receiving legs, three new chains were required. The remaining chains and all of the sprockets have been found in good condition, capable of many more years of service. On the 42 drives, 16 new chains and five sprockets are being supplied.

Cleaning Diesel Crank Cases

A NEWLY developed method of cleaning Diesel engine crank cases that is said to eliminate the long laborious scraping and wiping of surfaces incidental to hand methods used heretofore, is announced by Oakite Products, Inc., New York, N. Y. This new method is used in conjunction with a recently developed oil soluble emulsifier, Oakite Composition No. 9, which due to providing high emulsifying qualities and rapid penetrating action, makes possible fast, effective removal of sludge, grease and carbonized oil deposits. It is used with kerosene or light fuel oil. The mixture is sprayed on crank case surfaces and allowed to soak for a one to three hour period, depending on the condition of the crank case. After sludge, grease or other accumulations have been thoroughly softened and loosened, they are flushed away with a high pressure rinse, which completes the operation.

National Exposition of Power and Mechanical Engineering

ON MONDAY, December 5 to Saturday, December 10, inclusive, the Thirteenth National Exposition of Power and Mechanical Engineering will be held in Grand Central Palace, New York, N. Y.

This Exposition has developed to be a national market place for display of the newest research developments in power and mechanical engineering equipment. Industrial engineers and executives will find this an opportunity to inspect and compare competing equipment with a view to selection for optimum service and economy in individual plant installations.

Instruments and controls will be featured in many dynamic exhibits. Magnetic liquid level gages for atmospheric and pressure tanks up to 400 lb. pressure will be demonstrated. An absolutely tight job is made possible by the magnetic action, together with the use of a brass forged head. Boiler room guesswork and consequent danger is said to be eliminated by one manufacturer of combustion instruments and controls. Working models will show control panels in which all impulses are transmitted electrically.

A manufacturer of electrical safety switches, panelboards and switchboards will show a new duct system of electrical distribution. Every inch of this system is a potential outlet into which lighting fixtures or electric power appliances can be plugged for instant current.

Industrial testing machine exhibits will feature one which utilizes a high magnification recorder. Radio tubes register changes in length on a test bar, and chart this in relation to load; also an electric balancing machine determines the amount of unbalance in a rotating body, and meters this electrically. A complete line of manual, semi-automatic and automatic a.c. and d.c. starters, speed regulators and accessories will also be displayed. Electronic type voltage regulators and adjustable ratio auto-transformers for controlling lamp brilliancy likewise will be offered.

Included among the valve exhibits will be a new, column-type, liquid level controller which introduces a new method for the control of liquid level by means of an air pilot control mechanism. This construction embodies a displacement method for transmitting level change to the pilot valve with a minimum of friction lag. Valves that separate water and solids out of steam and compressed air as they flow through a self-contained separating unit will be shown. This equipment is equally adaptable for recovering liquids and for removing solids from gases.

A special steam trap will be demonstrated in actual operation. This display will consist of an electrically operated boiler that is completely enclosed and generating steam at about 20 to 22 lb. pressure. Reduced to 10 lb. pressure by means of a reducing valve it condenses about 8 lb. an hour. The condensate flows through the trap, which has glass on both sides, and is returned to the trap from an open receiver from from which a float operated motor driven pump returns the condensate to the boiler.

Other valve specialties will include liquid level controls, float valves, pressure regulators, balanced lever valves, and relief valves, blowoff units, pipe line separators, boiler drum separators, throttles, swivel joints, high-speed rotating joints, condensation coils, couplings, steam traps, pump governors and pressure gages.

Filters, both gas and liquid, will be exhibited in wide variety. For visitors whose interests pertain to turbines, steam and Diesel engines, a full line display of self cleaning filters and strainers will command attention. One exhibit will show a working model of an oil filter removing carbon black from oil.

Oil burners will be exhibited that use No. 6 oil fully automatically and are equipped with a viscosity valve to regulate automatically the amount of oil burned regardless of changes in the viscosity. Another exhibit will introduce a boiler water control that eliminates floats and valves operating in the steam. This equipment is intended primarily for boilers of 150 hp. and smaller.

Refractory and insulation materials will be interestingly presented. One exhibitor will show an improved plastic insulation for turbine bonnets, exhaust pipes, boiler drums, superheaters, flanges and fittings. Another exhibit will display a collection of boiler sidewall sections that have been removed from service for examination. These sidewalls will represent a variety of refractory materials, and effectively will demonstrate the degree to which each material stood up under actual operating conditions.

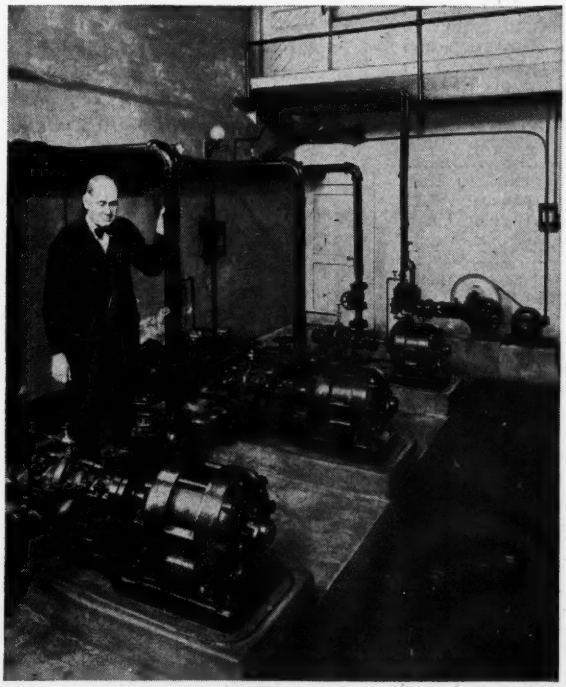
Power transmission appliances will be the subject of many important and comprehensive presentations including a "frictionized" belting, bearings of the type used on Anthony Fokker's 110-ft. yacht and on Howard Hughes' 'Round-the-World plane, spherical roller bearings, V-belts, round and flat endless belts, belt fasteners, industrial hose, silent and roller chain drives, worm and motorized helical gear reducers, anti-friction pillow blocks, flexible couplings, variable speed units, standard and overrunning clutches, speed control units, gears, and sprocket wheels.

Water treating chemicals for use in boilers, feed lines and other accessory equipment will be the subject of several exhibits. One display will feature a special "blinker" which indicates by electric lights the concentration of dissolved solids in the boiler water. CO_2 indicators and recorders will accompany other presentations of water conditioning equipment.

Over 270 exhibitors are planning displays at this year's New York Power Show which is held during the same week as the annual meeting of the American Society of Mechanical Engineers and the American Society of Refrigerating Engineers.

CITY SAVES $38,000!

Read How City of Hastings, Michigan, Saved Over $6300 a Year in Pumping Costs and Cut Water Rate 15% . . . by Replacing Old Pumps with Allis-Chalmers!



THE WATER DEPARTMENT AT HASTINGS, MICHIGAN. City Engineer Bert Sparks inspects the pumps that have saved the City of Hastings as much as $6372 in a single year! They are an Allis-Chalmers 2½" x 2" Type SJH, rated 250 gpm at 150 ft. head, and two Allis-Chalmers 3" x 2½" Type SJH pumps, each rated 350 gpm at 150 ft. head.

Water rate reduced 15%! Reserve fund of $11,000 built up by a department that previously showed a deficit. $38,000 saved in pumping costs!

That's what actually happened in the City of Hastings, Michigan, when City Engineer Bert Sparks replaced steam driven reciprocating pumps with three Allis-Chalmers motor-driven centrifugal pumps!

It's not hard to understand why! The former fuel cost for steam-driven pumps was 6c per 1000 gallons pumped. But the cost for the Allis-Chalmers motor-driven pumps is only 1¾c per 1000 gallons. That means an actual average saving of $6372 per year to the City of Hastings, in pumping costs alone! $38,000 since the pumps were installed!

Allis-Chalmers Engineering Cuts Costs!

No wonder that when a fourth pump was purchased in the fall of 1937, the City of Hastings specified Allis-Chalmers! For the engineering that has created Allis-Chalmers equipment means lower costs . . . actual savings in dollars and cents. And like savings result from Allis-Chalmers assumption of undivided responsibility for both pump and drive!

What Allis-Chalmers Centrifugal Pumps have accomplished for the City of Hastings, they can do for your city or for your factory. The Hastings installation is typical of the way Allis-Chalmers has solved municipal and industrial pumping problems throughout the country. There's an Allis-Chalmers representative near you. Let him show you how Allis-Chalmers pumps can actually pay for themselves . . . how many dollars they can save!

a23

CENTRIFUGAL PUMP DIVISION

ALLIS-CHALMERS

MILWAUKEE·WISCONSIN

SINGLE-STAGE DOUBLE-SUCTION PUMPS • CLOSE-COUPLED SINGLE-STAGE SSUnit PUMPS • MULTI-STAGE PUMPS • PAPER STOCK PUMPS • MIXED FLOW AND AXIAL FLOW PUMPS • AND SPECIAL DESIGNS FOR UNUSUAL APPLICATIONS

News from the Field

HENRY A. NELSON, Elmer K. Hansen and Lorence F. Pries, formerly for many years with American Steel and Wire Co., have formed the Central States Industrial Engineers to specialize in designing and building production machinery for wire and wire fabricated products, making surveys and appraisals. Offices will be at 229 Garden St., De Kalb, Ill.

J. N. WALKER has been elected Vice-President of Oxweld Acetylene Co., a Unit of Union Carbide and Carbon Corp., New York. Mr. Walker has been General Sales Manager of The Linde Air Products Co., also a Unit of Union Carbide and Carbon Corporation. T. D. Cartledge, formerly Assistant General Sales Manager of Linde Air Products Co., has been appointed General Sales Manager.

DR. FRANK BALDWIN JEWETT, vice president of the American Telephone and Telegraph Company and president of the Bell Telephone Laboratories, has been awarded the 1939 John Fritz Gold Medal, highest of American engineering honors, for "vision and leadership in science, and for notable achievement in the furtherance of industrial research and development in communication".

FRANK MALCOLM FARMER, vice president and chief engineer of the Electrical Testing Laboratories, New York, has been re-elected Chairman of the Engineering Foundation, research organization of the major national engineering societies, for 1938-39. Mr. Farmer, who enters upon his third term, is an authority on electrical measurements, electrical insulating materials, testing of engineering materials, and high voltage cables.

George E. Beggs, professor of civil engineering in Princeton University, was elected vice chairman. J. H. R. Arms will continue as secretary and Otis E. Hovey as director. The executive committee is headed by Mr. Farmer. Other members are A. L. J. Queneau, metallurgist of the United States Steel Corporation, New York; Professor W. I. Slichter of Columbia University, K. H. Condit of the National Industrial Conference Board, New York, and Professor Beggs.

ON OCTOBER 1 Edwin R. Rath joined Power Transmission Council, Inc., with headquarters in Boston, Mass., as senior engineer and will continue his consulting work on a national scale. Mr. Rath, a native of Nebraska, was educated at the University of Pittsburgh, graduating in 1917 with a Bachelor of Science Degree in Electrical Engineering.

D. ROBERT YARNALL, chief engineer of the Yarnall-Waring Co. of Philadelphia, has been reelected president of United Engineering Trustees, of which the Engineering Foundation is the research organization. Other officers were named as follows: Henry A. Lardner of J. G. White Engineering Corp., New York, first vice-president; Albert Roberts, secretary of the Minerals Separation North America Corp., New York, second vice-president; H. R. Woodrow, vice-president of the Consolidated Edison Co. of New York, treasurer; J. P. H. Perry, vice-president of the Turner Construction Co., New York, assistant treasurer. John H. R. Arms, general manager of the Trustees, the headquarters of which is the Engineering Societies Building, 29 West 39th Street, continues as secretary.

RECIPIENTS OF honors and awards, to be presented on December 6, at the 59th Annual Meeting of The American Society of Mechanical Engineers in New York City, were announced November 5 by C. E. Davis, Secretary of the Society. The Holley Medal will be given to Francis Hodgkinson for "meritorious services in the development of the steam turbine"; the Worcester Reed Warner Medal, to Lawford H. Fry, for "written contributions relating to improved locomotive design and utilization of better materials in railway equipment"; the Melville Medal for 1938, to Alphonse I. Lipetz, for his paper on "The Air Resistance of Railroad Equipment"; for outstanding achievement in mechanical engineering for 1938, the Pi Tau Sigma Medal will be given to Wilfrid E. Johnson; the A.S.M.E. Junior Award, to Arthur C. Stern, for his paper "Separation and Emission of Cinders and Fly Ash"; the Charles T. Main Award of $150 for student engineers, to Edward W. Connolly, for his paper on "Economic Limitations in Engineering Design—With Concrete Examples"; the A.S.M.E. Postgraduate Student Award, to Marshall O. Long, for his paper on "An Investigation Into the Angular Characteristics of an Adjustable Blade Current Meter"; and the A.S.M.E. Undergraduate Student Award to Donald C. McSorley, for his paper on "Humidity Insulation."

WILDER A. CHAPMAN has been appointed Manager of Laboratories for Robert W. Hunt Co., Engineers, with headquarters at Chicago.

FRANK J. TONE, President of The Carborundum Co., announces the appointment of Charles Knupfer and Henry P. Kirchner as Vice-Presidents. Arthur Batts the Secretary of the Company, and Charles Knupfer were chosen members of the Board.

HERBERT J. WINN, retiring President of the 87-year-old Taylor Instrument Companies, becomes Chairman of the Board of Directors and is succeeded in the presidency by Lewis B. Swift who has served as Vice President in Charge of Engineering and Research. Mr. Karl H. Hubbard has been appointed chief engineer, in charge of Engineering Research and Design, and Dr. H. L. Mason will succeed him as head of the Research Division. Official announcement was made November 9th. Other officers chosen by the board of directors include: Vice Presidents, P. Richard Jameson, Henry W. Kimmel, and Fred K. Taylor; treasurer, Herbert J. Noble; secretary, Henry W. Kimmel; assistant secretary, George H. Taylor.

HOTEL COMMODORE New York has been selected as headquarters for the 34th Annual Meeting of The American Society of Refrigerating Engineers, which will be held December 6, 7 and 8, with the three main sessions devoted to the newest developments in air conditioning, industrial refrigeration, and commercial and food refrigeration. Besides a particularly significant list of papers, a new feature of the annual meeting will be the departmental conferences held on Tuesday afternoon, December 6, when quick freezing, humidity problems in air conditioning, and market research in refrigeration will be discussed informally to smaller groups, in each case with an authority on the subject leading the general discussion.

Technical sessions proper are to be held only on the mornings of the three days of the convention, with Tuesday afternoon assigned to the departmental conferences, and Wednesday and Thursday afternoons left free for inspection tours, visits to the Power Show, and A.S.M.E. sessions.

UNDER THE SPONSORSHIP of the Refrigeration Supplies & Parts Manufacturers' Association, of which J. D. Colyer, Wolverine Tube Co., Detroit, Mich., is president, a refrigeration and air conditioning exhibition is being planned at the Stevens Hotel in Chicago for January 16-19, 1939. It is said that several trade associations and engineering societies are supporting the exhibition and will hold group meetings. Details are being handled by R. M. McClure, Manager, Refrigeration and Air Conditioning Exhibition, 111 W. Washington St., Chicago, Ill.

ANNOUNCEMENT was made recently by B. C. Smith, general manager and designer, of the Standard Motor Co., Redbank, N. J., that this company has taken over the organization and business of the Standard Diesel Engine Co. and the Standard Motor Construction Co. of Jersey City, N. J. They are now manufacturing Standard Diesel and gasoline engines in sizes ranging from 15 to 600 hp. at the Red Bank, N. J., plant, and are in a position to furnish parts and service for all models of Standard engines, regardless of age.

THE MANHATTAN RUBBER MFG. CO., now The Manhattan Rubber Mfg. Division of Raybestos-Manhattan, Inc., of Passaic, N. J., observed the forty-fifth anniversary of the founding and incorporation on October 28.

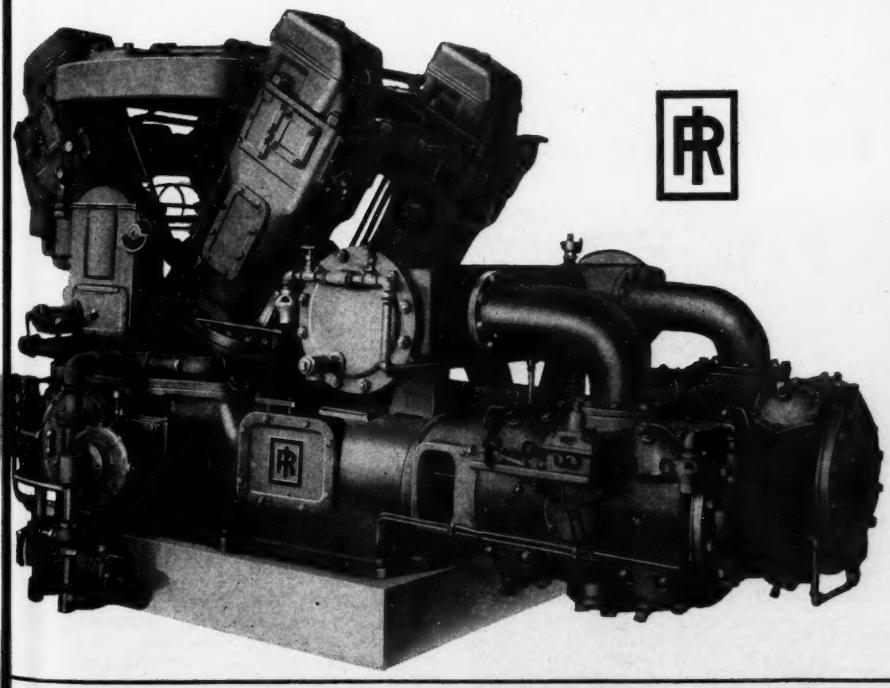
Frank Cazenove Jones, the first President, was forced to retire in 1903 because of ill health and was succeeded by Col. Arthur F. Townsend, who served as President for 26 years up to the merger in 1929 which formed Raybestos-Manhattan, Inc. Since 1929 Col. Townsend has been Chairman of the Board of Raybestos-Manhattan, Inc., and General Manager of The Manhattan Division. Three other early executives of the company are still active. They are: F. L. Curtis, C. T. Young, and Miss Margaret A. Hogan. Manhattan now employs approximately 3000 persons in a plant that covers 800,000 square feet of floor space. Auxiliary plants have been established at Whippany, New Jersey, Neenah, Wisconsin, and North Charleston, South Carolina.

933 CU. FT. OF AIR for 1¢

*For every cent spent for fuel oil the XVO will compress 933 cu. ft. of free air to 100 pounds pressure.

*Based on fuel oil at 6 cents per gallon.

The New XVO Diesel-Engine-Driven Compressor



THIS new compressor combines a *heavy-duty, four-cycle Diesel engine* and a *horizontal heavy-duty, double-acting compressor* in a single, compact and comparatively light-weight unit which operates at a moderate speed. High over-all efficiency is the natural result of such a unit. It is the outstanding Diesel-driven compressor of today.

This compressor is built in sizes of 4, 6, or 8 power cylinders, rated respectively at 625, 935 and 1250 cfm. actual free-air capacity at 100 pounds pressure. Compressor cylinders can be furnished for vacuums, for pressures up to 5000 pounds, and for air, gas or ammonia compression.

The frame, running gear and compressor cylinders are the same as for our Type XVG gas-engine-driven unit of which there are more than 125,000 installed horsepower. The fuel and combustion systems of the XVO are the same as those of the Ingersoll-Rand Type S Diesel engine, a pioneer in its field.

The XVO is conservatively rated for 24 hours-a-day, full-load service. When economy dictates the use of Diesel engines, the XVO compressor is the logical choice.

More detailed information on its money-saving features is contained in Bulletin 3072. May we send you a copy?

I-R Products: Compressors, Rock Drills, Pneumatic Tools, Oil Engines, Pumps, Condensers, Refrigerating Units

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DONALD A. ROBISON, formerly treasurer of the Caterpillar Tractor Co., has been appointed to the post of general sales manager. W. J. McBrian, formerly domestic credit manager, has been appointed treasurer. Mr. Robison was born in Nevada, graduated from the University of Nevada in 1926 and started to work for the company at San Leandro, Calif., the same year. He has been in Peoria since 1930 and has been treasurer since 1937.

WALTER JEHU has been appointed District Manager of The Timken Roller Bearing Co.'s Boston, Mass., office located at 1107 Commonwealth Ave. Mr. Jehu was formerly General Manager of The Timken Roller Bearing Co. Ltd., Toronto, Ontario.

National Accounting Conference

UNDER the joint sponsorship of the Edison Electric Institute and the American Gas Association, the Second National Accounting Conference of the electric and gas industries will be held at the Palmer House, Chicago, Ill., on December 12, 13 and 14, 1938. The general session of the conference will be confined to matters relating to the broader aspect of accounting. The principal themes will be, first, accounting economies; second, ethics and accounting personnel training; third, depreciation and plant accounting problems. Speakers of national reputation, representing government regulatory agencies, as well as educational, engineering and manufacturing phases of the business, will address the conference. December 12 will be devoted to the use of group committees, while the general sessions will occupy the last two days.

Everyone A Partner

THOSE DAYS when tuberculosis was looked upon as a destructive visitation of Providence—a hopeless hereditary disease about which nothing could be done—are pictured on the 1938 Christmas Seal offer for sale to those who wish to join the campaign to eradicate this disease. Homes are safer today. There is at hand sufficient knowledge to

control this disease. But, we must not be too complacent over the results. It ranks first as a killer in the important years from 15 to 45. Christmas Seals are now on sale everywhere.

Frank P. Meyer

FRANK P. MEYER, a well-known figure in the piping industry and a director of Pittsburgh Piping & Equipment Co., Pittsburgh, Pa., died after two days illness on Wednesday, October 19. He entered the employment of Pittsburgh Piping at the age of 20 as an estimator

Frank P. Myer

when the company was founded in 1903. He quickly advanced to the position of chief engineer. Mr. Meyer was elected a member of the Board of Directors of Pittsburgh Piping in 1928. The first of this year he advanced to the position of manager of the Engineering Department.

Walter Sherman Moody

WALTER SHERMAN MOODY, 74, a pioneer in transformer design and in charge of this important work for General Electric from 1892 until 1927 when he was named consulting engineer by the company, died at his home in Pittsfield, Mass., Nov. 7 following an illness of several months. Mr. Moody retired from active work in 1931, completing 43 yr. service with General Electric.

Mr. Moody was born in Chelsea, Mass. on September 20, 1864, the son of Luther R. Moody and Emily M. Sherman. He was graduated with a degree

One Diesel Locomotive a Day

SINCE starting in 1936, the Electro-Motive Corp. at La Grange, Ill., a General Motors subsidiary, has turned out over $25,000,000 worth of manufactured material, represented largely by 225 Diesel locomotives aggregating 210,000 hp. Recent completion of a 300,000 sq. ft. addition brings the total manufacturing area to approximately 14 a. devoted exclusively to Diesel locomotive production. The plant is now manufacturing everything, not requiring a foundry or heavy forge shop, including 600, 800, 1200 and 1600 hp. General Motors two cycle Diesels, two sizes of generators and two sizes of traction motors used in the locomotive transmission system.

Some 2000 are employed and the capacity of the plant is one locomotive a day. The largest yet contracted for are 6000 hp. units for the Seaboard Orange Blossom Special and intended to pull a train of 14 standard Pullmans. Locomotives have been limited to switch or passenger service but H. L. Hamilton, president, said that there is an insistent demand for a freight locomotive and that the year 1939 should see one in service. He also said that since 1936 the cost of a switch engine had been reduced about 24 per cent.

"I've Licked Wear and Care with this new Jenkins 'Armor Seat' Valve"

Special Alloy Steel Plug and Seat
EXCEEDING 500 BRINELL HARDNESS

So hard—that it cannot be cut by throttled steam—nor harmed by boiler scale, pipe chips, welding beads, grit, rust. Here's a valve to cut your costs on hard duty service—such as throttling for pressure reduction, water column blow-down, drips, drains, soot blowers, injectors, heating coils or any close regulation of steam. Try it on the toughest job in your plant.

This is but ONE of 87 JENKINS REGRINDING VALVES

Many types, many patterns.
Regrinding Regrind-Renew
Bevel Seat Plug Seat
Special Alloy Seats
Bronze Body Iron Body
All-Bronze All-Iron
Union Bonnet Bolted Bonnet
125 to 300 Pounds Working Steam Pressures
175 to 600 Pounds Working Oil, Water, Gas Pressures

JENKINS Fig. 976 "Armor Seat" Regrind-Renew Valve, here illustrated, is the king pin in the complete line of Jenkins Regrinding Valves. In addition to its special alloy steel plug and seat of unique design to insure uniform contact over entire length of seat, this valve provides many other advantages that assure long life and trouble-free service including:—

Perfect-grip handwheel · Extra heavy bronze body · Heavy manganese bronze spindle · Self-aligning packing gland · Extra deep stuffing box · More spindle threads in contact with bonnet · Large, heavy union bonnet · Complete interchangeability of parts.

Into these valves are built that extra quality and extra stamina synonymous with Jenkins—your assurance of low cost maintenance and freedom from expensive replacements.

Ask your supply man for this valve — or write to us for Folder 176.

JENKINS BROS., 80 White Street, New York, N. Y.; Bridgeport, Conn.; Boston, Mass.; Atlanta, Ga.; Philadelphia, Pa.; Chicago, Ill.; Houston, Texas; Montreal, Canada; London, England

Jenkins

gives you <u>everything</u> in Regrinding Valves

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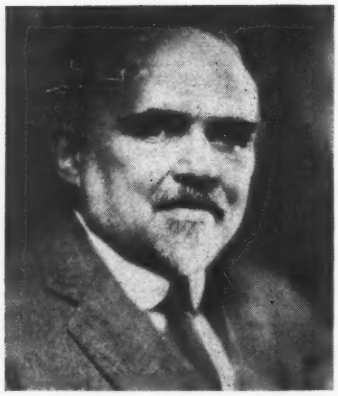


Walter Sherman Moody

in electrical engineering from the Massachusetts Institute of Technology in 1887, the first class in electrical engineering to be graduated from that institution. He became an instructor in physics and electrical engineering at M.I.T., holding this position from 1887 to 1888. While acting as instructor, Mr. Moody met William Stanley on the occasion of the demonstration before the Massachusetts Society of Arts of the Goulard and Gibbs alternating-current system. Impressed with the personality of Mr. Stanley and his exposition of the possibilities of alternating-current distribution of power, he forthwith made it his particular field of research.

Mr. Moody was especially known in the electrical industry for his work in connection with the H-type distribution transformer, and for his air-blast transformer design. Equally as important was his pioneer work in the use of silicon sheet steel for transformers and other electrical equipment. Perhaps more than any other person he was responsible for the progress made in this line. He was first to apply this steel to transformer use.

For the Engineer's Library

Any Catalogs that you wish will be gladly sent. Write Power Plant Engineering.

Mechanical Power Transmission

Ball and Roller Bearing Greases, made with filtered paraffine-base oil is the subject of a new bulletin recently issued by E. F. Houghton and Co., Philadelphia, Pa.

Bearings—A new book illustrates and describes the various types of engine bearings, bearing liners and bushings in general use, the newer types now coming into wider use, and the methods of design and manufacture which are important influences in the price you pay and the performance you obtain. It illustrates a wide variety of modern bearing and bushing applications on machines and appliances. It discusses the advantages of applying designs and alloys developed in automotive practice to modern machines. A copy of this new book will be sent on request to the Federal-Mogul Corp., Detroit, Mich.

Machinery—A 48-page picture book illustrates the company's manufacturing facilities and many of their products and installations. The purpose of this book is to acquaint industry with the wide scope of its line of power transmission and materials handling machinery and fabricated steel. Reference is made to sectional catalogs available for those desiring complete information. Palmer-Bee Co., Detroit, Mich.

Rossman System of Adjustable Speed Control—Bulletin 1151-13 under this title goes into the operating principles of this system which involves a method of controlling the speed of these specially designed alternating current driven machines over wide ranges at high efficiencies. The construction of these units and the versatility of their application to pumps, fans, blowers, etc., and their adaptability to automatic control if desired is also discussed. The bulletin includes interesting diagrams, curves and tables applying to this system. Allis-Chalmers Mfg. Co., Electrical Division, Milwaukee, Wis.

Insulation

Insulation—A new catalog on B-H Rockwool Insulation materials for industrial use gives a general description of such products as Insulation wool, a loose fill material; Rockwool blanket; No. 100 pipe insulation; No. 7 insulating block; No. 1 insulating cement; Weatherseal; Diatomaceous earth products; Asbestos cement; Asbestos wick and rope; Fibrous adhesive and finishing cement. The Baldwin-Hill Co., 577 Klagg Ave., Trenton, N. J.

Handling Heat—RC 1133 Crystolon Refractory Cement, an economical silicon carbide cement for general service in furnace linings is illustrated and described in a new bulletin recently issued by Norton Co., Worcester, Mass.

Dilecto, phenol fibre, a laminated plastic which was developed to meet the demand for a waterproof insulating material possessing great mechanical strength and adaptability to all fabricating operations is illustrated and described in a 48-page catalog recently prepared by the Continental Diamond Fibre Co., Newark, Del.

Insulag—A refractory lagging for temperatures up to 2200 deg. F. is illustrated and described in an 8-page Bulletin 327-C which has just been issued by the Quigley Co., 56 West 45th St., New York, N. Y.

Combustion Equipment

C-E Direct Fired Systems for Burning Pulverized Coal is the title of a new 36-page catalog containing a synopsis of the development of pulverized coal firing and its influence on the capacities and designs of steam generating units. Combustion Engineering Co., Inc., 20 Madison Ave., New York, N. Y.

Stoker—A new catalog, No. 140, describes the Detroit Multiple Retort Stoker which is designed for large boilers and high capacities. Detroit Stoker Co., Fifth Floor, General Motors Bldg., Detroit, Mich.

Welding

Welding—A new bulletin of untouched photographs showing some examples of welded plate construction which the company has built in the past year. Edge Moor Iron Works, Inc., 30 Rockefeller Plaza, New York, N. Y.

Hard-facing with Haynes Stellite Rod—An extensively revised folder under this title presents the complete procedure for hard-facing steel wearing surfaces by the oxy-acetylene process. The procedure is condensed so that it can readily be followed by a welding operator, even when he is actually hard-facing a part. In addition, the publication contains all necessary data on the different grades of Haynes Stellite hard-facing rod. Haynes Stellite Co., Kokomo, Ind.

Controls

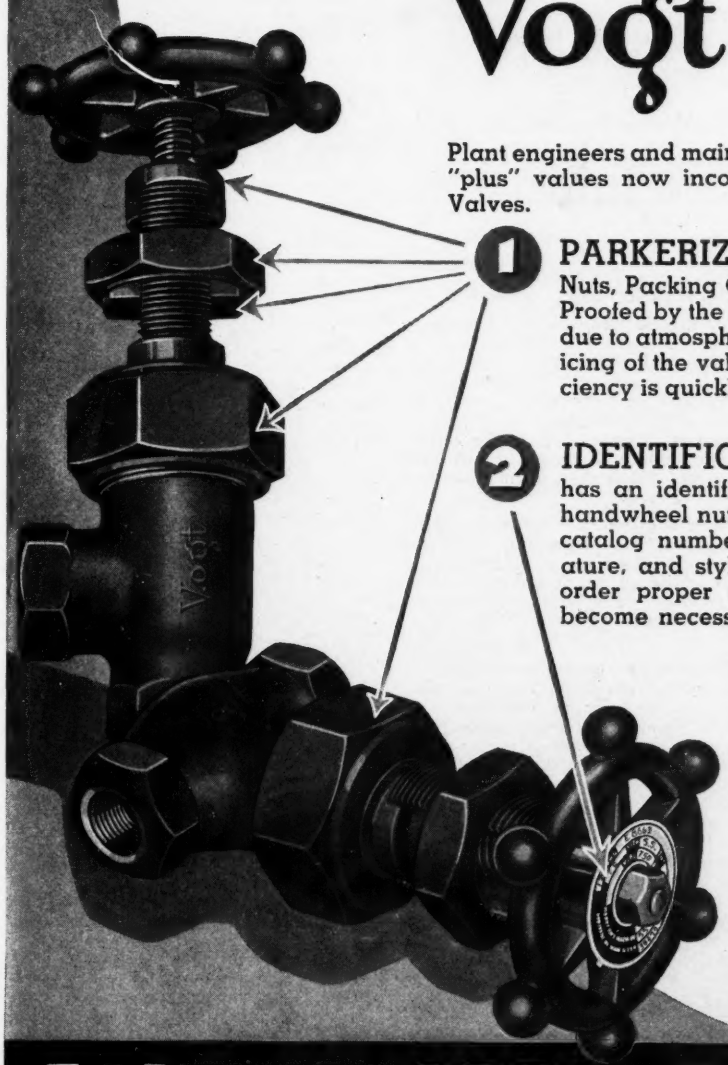
Automatic Controller—Catalog 35, newly published, describes in detail pump governors, regulators, liquid level controllers, valves, traps and strainers. It is divided into 12 sections, and contains 16 pages of the well known Fisher capacity charts so useful in sizing controllers properly for all fluids and all conditions. These new capacity charts are now more complete and easier to read than before. Fisher Governor Co., Marshalltown, Iowa.

Pressure Reducing Regulator is illustrated and described in a new 8-page bulletin giving features, operation and installation. Foster Engineering Co., 109 Monroe St., Newark, N. J.

2 NEW FEATURES

that add to the superiority of

Vogt VALVES



Plant engineers and maintenance men will welcome these new "plus" values now incorporated in Vogt Drop Forged Steel Valves.

1 **PARKERIZING.** Valve Bonnets, Bonnet Nuts, Packing Glands and Packing Nuts are Rust Proofed by the Parker Process. Galling of threads, due to atmospheric corrosion, is eliminated. Servicing of the valve to maintain high operating efficiency is quickly and easily accomplished.

2 **IDENTIFICATION DISC.** Each valve has an identification disc held in place by the handwheel nut. This disc records the valve size, catalog number, working pressure and temperature, and style of trim, thus making it easy to order proper replacement parts if that should become necessary.

HENRY VOGT MACHINE CO.
INCORPORATED
LOUISVILLE, KENTUCKY
NEW YORK CHICAGO PHILADELPHIA
CLEVELAND KANSAS CITY DALLAS

Vogt DROP FORGED STEEL Valves

Boiler Instruments and Accessories

The Vigilant Feedwater Regulator is the subject of a new 60-page catalog giving a complete story of the subject from the time it was invented to the present time, including uses, operation and features of design. Also included in the catalog are other steam specialties made by the company. The Chaplin-Fulton Mfg. Co., 28-40 Penn Ave., Pittsburgh, Pa.

Tube Cleaners—Bulletin 13, under this title, illustrates and describes Airetool tube cleaners, giving sizes, uses and operation of each type. The Airetool Mfg. Co., Springfield, Ohio.

Bloff-off Valves for Oil Field Boilers is the title of a new 4-page Bulletin B-423 describing three different types of blowoff valves for working steam pressures up to 500 lb. Yarnall-Waring Co., Chestnut Hill, Philadelphia, Pa.

Indicating Radiation Pyrometers—Leaflet B-1138 gives a brief description of the types of this pyrometer. Thwing-Albert Instrument Co., 3319-41 Lancaster Ave., Philadelphia, Pa.

Automatic Control For Steam Generating Units is the title of a new 12-page bulletin in color. Principle of operation, diagrammatic installations and typical photographs are used to supplement the text and explain the application to gas fired, stoker fired, oil fired and pulverized fuel fired boilers. Askania Regulator Co., 1603 So. Michigan Ave., Chicago, Ill.

Feedwater Regulation—A new catalog (Bulletin S-20-D) comprising two distinct bulletins in one, with appropriate covers for each describes applications of feedwater regulators and differential pressure control. Fully illustrated with photographs, diagrams, hookups. The Swartwout Co., 18511 Euclid Ave., Cleveland, O.

Prime Movers

Piston Rings—Bulletin 385 announces a new development in the art of making piston rings. C. Lee Cook Mfg. Co., Louisville, Ky.

The Robert B. Morse Water Works at Burnt Mills, Md. is the title of an article by H. B. Hall, Chief Engineer of the District, which has been reprinted by the De Laval Steam Turbine Co., Trenton, N. J.

Generator—A new bulletin, No. 1193, on the uniquely designed Synchro-Operator for automatically paralleling AC generators, synchronous condensers, tie lines and frequency changers. The bulletin fully describes and illustrates this speedy automatic synchronizer which does away with the usual hazards of manual synchronizing in any type of generating plant. Allis-Chalmers Mfg. Co., Switchgear Division, Milwaukee, Wis.

Maintenance and Inspection of Steam Turbine Generating Units and Auxiliaries. This is a 15-page reprint of a paper delivered by Hans Dahlstrand, engineer in charge. Steam Turbine Dept., before the Wisconsin Utilities Association. It is published by Allis-Chalmers Mfg. Co., Milwaukee, Wis., as Leaflet 2337.

Hydraulic Turbines—Under the title Power By Smith, a 56-page Bulletin 139 illustrates and describes the Smith-Kaplan Turbine covering construction and operation. Also included are a number of illustrations of typical installations. S. Morgan Smith Co., York, Pa.

Diesel—A new 40-page bulletin on Type "S" Diesel engines has just been published. This machine is a heavy-duty, continuous-service, compact engine for stationary or marine-electric application. The bulletin contains many illustrations of the engine parts, explaining the relationship of their design to the economical installation and operation characteristics of the unit. Several pages are devoted to application views on a variety of services in various parts of the world. In addition, specifications, dimensions, cutaway views and other information are contained in the catalog, form 10110, copies of which are obtainable from the Ingersoll-Rand Co., 11 Broadway, New York, N. Y.

Water Treatment

Increase Boiler Efficiency—Reduce Costs is the title of a bulletin describing Corrosan as a self-applying boiler metal treatment which keeps the boiler clean, scale free and rust proof. It also gives information as to how this material works and how it may be applied. Ferrotect Industries, South Orange, N. J.

Continuous Blowdown System—This new Bulletin No. 510 presents a treatise on the subject of continuous blowdown systems for steam boiler plants. The need for such systems is illustrated by typical plant studies with useful charts and tables. The latter also point out savings to be realized with heat exchangers. Elgin Softener Corp., Elgin, Ill.

Ferec Iron Removal Filters designed to remove iron minerals from water by a new process known as catalyitc filtration is the subject of a new informative technical bulletin just released by Wm. B. Scaife and Sons Co., Oakmont, Pa.

Evaporators for producing distilled boiler feed from hard or salty raw water is the topic of discussion in Bulletin 362. It explains plant operating conditions for which evaporators are desirable, outlines the general features and advantages of evaporators for producing pure boiler feed make-up, and describes the distinctive design of Griscom-Russell scale-shedding Bentube Evaporators. The bulletin is profusely illustrated and contains a number of typical heat flow and heat balance diagrams. The Griscom-Russell Co., 285 Madison Ave., New York, N. Y.

Piping & Fittings

Solenoid Valves for steam, gas, liquids and air are illustrated and described in a new catalog giving applications, sizes and specifications of each type. Automatic Switch Co., New York, N. Y.

Repair Clamps and Saddles for Steel and Cast-Iron Pipe is the title of 32-page catalog 38A which has just been issued by M. B. Skinner Co., South Bend, Ind.

Valves—Six advertisements compiled in a bulletin illustrate and describe the materials which go to make up Edward valves. Edward Valve & Mfg. Co., Inc., East Chicago, Ind.

New Pipe Threaders—A new broadside which gives complete information on the new No. 65R and 85R series pipe threaders, with all-steel and malleable-alloy construction. These new tools thread 4 sizes of pipe with one set of chasers, offer a choice of two new workholders, a cam and plate type. This literature also describes the new No. 1R series poster pipe threaders with all-steel and malleable-alloy construction; 4 sets of chasers; full floating, separately replaceable posts, choice of cam or plate type workholders. Chaser dies fit any make of poster threader and all dies of the same number are interchangeable with similar number of any other Ridgid Poster set. The Ridge Tool Co., Elyria, Ohio.

Miscellaneous

The Preservation of Business Records—A pamphlet recently issued by the Business Historical Society, Baker Library, Soldiers Field, Boston, Mass., supplies the answers to the following four questions: 1. Why should business records be preserved? 2. What material should be selected for preservation? 3. How should records be preserved? 4. When should preservation be undertaken?

Heavy Duty Portable Vacuum Cleaners—A new 8-page booklet, No. A-303, attractively printed in two colors and well illustrated, describes the Hoffman heavy duty industrial portable vacuum cleaning units. The booklet deals briefly with the nature of dust hazards and considerable space is devoted to the practical considerations involved in planning a dust removal system. Special applications designed by Hoffman to simplify industrial cleaning problems are illustrated and described as are the corporation's various units. United States Hoffman Machinery Corp., Air Appliance Division, 105 Fourth Ave., New York, N. Y.

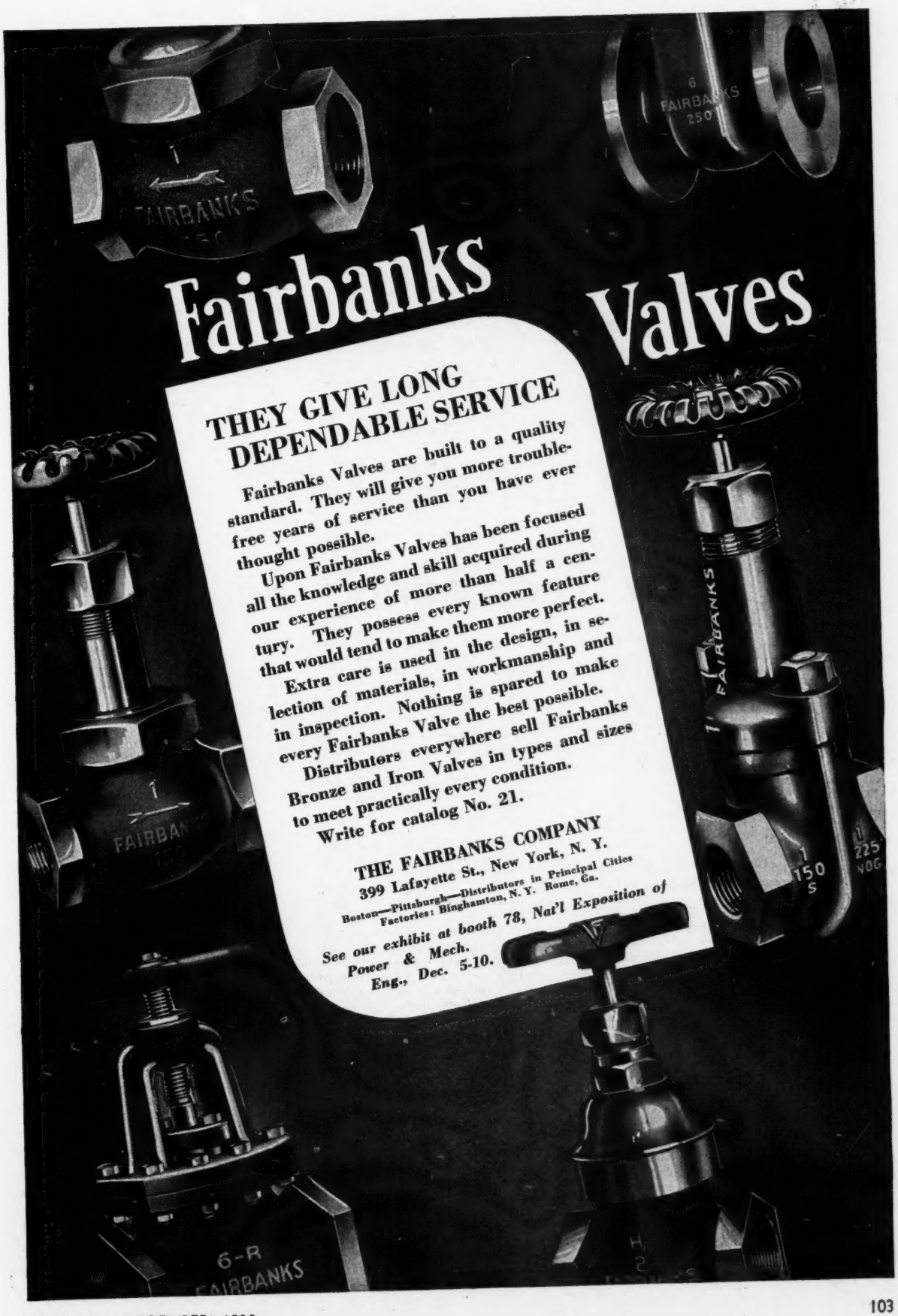
Materials

Leather Packings for every industrial purpose is the title of a pocket size 32-page catalog giving a complete treatise of the subject. Alexander Brothers, 406 North Third St., Philadelphia, Pa.

Heat and Corrosion Resistant Castings for Industrial Applications is the subject of a 24-page catalog well illustrated with a number of photographs showing the production of these castings. American Manganese Steel Div. of the American Brake Shoe and Foundry Co., Chicago Heights, Ill.

Fire Protection—A new bulletin, BN-497, on Kidde Fire-Fog Systems for the protection of outdoor electrical equipment is announced by Walter Kidde & Co, Inc., 140 Cedar St., New York, N. Y.

Colloidal Graphite—A technical bulletin pertaining to the application of colloidal graphite to industry was recently issued by the Acheson Colloids Corp., Port Huron, Mich.


Fairbanks Valves
THEY GIVE LONG DEPENDABLE SERVICE
Fairbanks Valves are built to a quality standard. They will give you more trouble-free years of service than you have ever thought possible.
Upon Fairbanks Valves has been focused all the knowledge and skill acquired during our experience of more than half a century. They possess every known feature that would tend to make them more perfect. Extra care is used in the design, in selection of materials, in workmanship and in inspection. Nothing is spared to make every Fairbanks Valve the best possible. Distributors everywhere sell Fairbanks Bronze and Iron Valves in types and sizes to meet practically every condition.
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THE FAIRBANKS COMPANY
399 Lafayette St., New York, N. Y.
Boston—Pittsburgh—Distributors in Principal Cities
Factories: Binghamton, N. Y. Rome, Ga.
See our exhibit at booth 78, Nat'l Exposition of Power & Mech. Eng., Dec. 5-10.
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Heating and Air Conditioning

Bacteria Control in Air Conditioning is the title of a recently revised, 16-page booklet describing and illustrating the latest methods for effectively handling the many necessary cleaning operations in connection with air conditioning system maintenance. Oakite Products, Inc., 14 Thames St., New York, N. Y.

National Unit Heaters are illustrated and described in a new 8-page bulletin giving applications, steam basic ratings and dimensions of the different sizes of heaters. National Radiator Corp., Johnstown, Pa.

Pumps

Single Suction Multistage Pumps, which are widely used for feeding high pressure steam boilers and other high pressure service, are described in a 36-page illustrated catalog. Their advantages, as compared with the drum type of balanced, are explained by a numerical example. De Laval Steam Turbine Co., Trenton, N. J.

Pump—Bulletin W-318-B1B illustrates and describes the Balanced Multi-stage Volute Centrifugal Pump. Vertical Triplex single-acting power pumps is the title of Bulletin W-423-B5. Worthington Pump & Machinery Corp., Harrison, N. J.

Chemical Pumps for Pressures—A new bulletin, No. 938, entitled "Milton Roy Chemical Pumps and Proportioners" describes and illustrates several improved models of single and multiple unit motor pumps designed for pumping any type of chemical in exactly the desired volume against pressures ranging from 0 to 15,000 lb. The bulletin describes outstanding features of design and construction, shows typical applications and gives specifications on 172 pump tables and sizes, including capacities, maximum pressures, and motor horsepower. Milton Roy, 2031 E. Madison St., Philadelphia, Pa.

Electrical Equipment

Circuit Breakers—Catalog 6-B illustrates and describes a new addition to the company's line of oil circuit breakers which are designated as Class 50-XX. The Roller Smith Co., 233 Broadway, New York, N. Y.

Explosion-Proof Motors, approved by Underwriters' Laboratories for Class I Group D hazardous locations, insure against accidental ignition or explosion of vapors or gases which are prevalent in plants producing or employing gasoline, acetone, alcohols, volatile oils or combustible gases, are fully described in Bulletin 1225. Fairbanks, Morse & Co., 600 S. Michigan Ave., Chicago, Ill.

Electricians' Tools—such as electric soldering tools, wire strippers, insulation tester, electric etcher and marker and power driven undercutter are illustrated and described in a bulletin which includes practically all the equipment made by the Ideal Commutator Dresser Co., 1236 Park Ave., Sycamore, Ill.

Type J Rocking Contact Rheostat Generator Voltage Regulator is the title of Bulletin 1194 which is highly illustrated and produced in color and describes the company's most modern design of their well known rocking contact type of regulators for control of large and important synchronous machines. Besides including a number of interesting complete operating diagrams and detail views of the apparatus, it points out the many inherent advantages of this high speed type of voltage regulator. Allis-Chalmers Mfg. Co., Milwaukee, Wis.

New Engineering Books

Preparation of Reports. By Ray Palmer Baker and Almonte Charles Howell. Published by The Ronald Press Co., 15 E. 26th Street, New York City. Size 5½ by 8 in., 548 pp., cloth bound. Price $4.00.

With the exception of operating men, whose actions are more important than their words, an engineer's reputation hangs or falls upon his ability to present an interesting, accurate and intelligent report. In the active pursuit of technical knowledge the importance of this is apt to be overlooked. A certain facility in the use of language is a requisite yet a rhetorical cleverness does not make a satisfactory report. An author of a report must have a clear realization of its character, and its purpose in relation to the conditions from which it springs.

Reports are as individual as their authors and style is as diverse but there are certain fundamental principles of organization, or, design if you prefer, which are admirably set forth in this text. Origins, forms, necessary elements, characteristics and the effective presentation of statistics are covered in the first part of the book. Different types such as information, examination, experimental research and recommendation reports are then taken up, with a final chapter on proper preparation of the manuscript and proof reading.

One of the most interesting features of the book is a large number of examples showing current practice among top ranking men and effectively demonstrating how the material used affects the form of the report and the method of approach. This revised edition has been broadened considerably so as to include economics and business as well as science and engineering. Methods of presentation have been developed in courses of report writing by the authors who are respectively Assistant Director of Rensselaer Polytechnic Institute and Professor of English of the University of North Carolina.

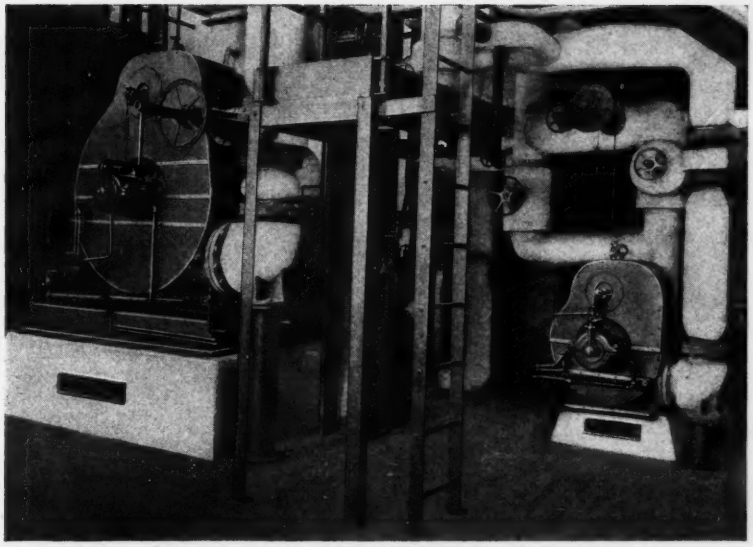
Diesel Engines. By B. J. von Bongart. Published by D. Van Nostrand Co., Inc., 250 Fourth Ave., New York, N. Y. Size 6½ by 9½ in., cloth bound, 326 pp. Price $5.50.

Here is a book on Diesel engines written for engineers and setting forth in a straightforward manner the author's experience as a Diesel consultant with the researches and experience of others added to include the full scope of modern development. A brief chapter on the development work preceding Dr. Diesel's patent is followed by chapters on thermodynamics, combustion and fuel oils, unusually well illustrated by charts, photographs and diagrams which do much to fix in the readers' minds the fundamentals with which the engineer must work. Fuel atomization, fuel pumps, injection systems and combustion chamber design are covered in separate chapters, using representative designs as type examples without attempting to describe in detail all modern engines. Because the high speed engine now presents the major problems, this type of engine has been dealt with more fully than the medium and low speed types and separate chapters are devoted to automotive and aircraft designs. Europeans have progressed farther in these lines than the Americans due largely to economic factors. Both fields offer possibilities which are being carefully explored. Superchargers and miscellaneous Diesel design features occupy the last three of the 15 chapters.

Molybdenum in Steel. Published by the Climax Molybdenum Co., 500 Fifth Ave., New York, N. Y. Size 8½ by 11 in., loose leaf with flexible fabricoid binding, 118 pp. Sent to metallurgists and engineering executives who write their requests on company letterhead.

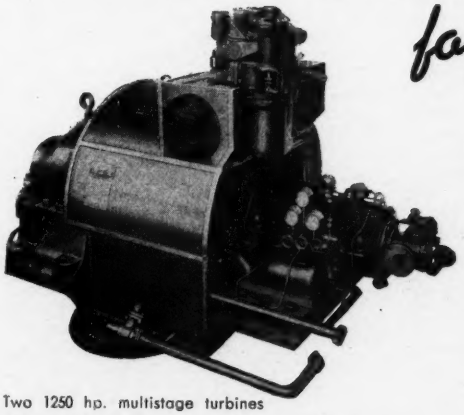
Because of the improvement in physical properties, alloy steels are now widely used in industry and since the advent of high temperatures have become invaluable in power plant work. Either separately or in combination with nickel, manganese, silicon or chromium, molybdenum alloys are in wide use and this book, divided into 13 sections, gives data on the various types. Sections 8 to 13 discuss various alloy steels from the standpoint of elevated temperatures, corrosion resistance, nitriding, die steels, high speed steels and cast steels, while sections 2 to 7 discuss in detail the effect on physical properties of molybdenum, nickel, chromium, silicon, manganese in various combinations and percentages. Section 1 is an introduction and section 14 a general index. Each section consists of a general discussion of the particular steel or steels involved with data on physical properties in tabular and curve form.

One of three De Laval geared velocity stage turbines driving induced draft fans, using steam at 450 lb. gage and 750° F. and exhausting against 5 lb. gage back pressure; 550 hp. each at 3480 r.p.m. turbine speed and 725 r.p.m. fan speed; also one of three De Laval geared velocity stage turbines driving forced draft fans.

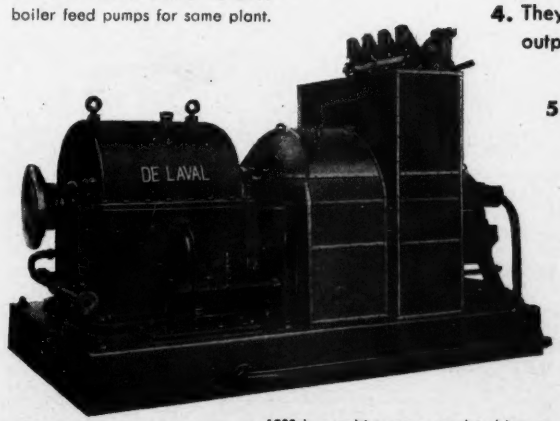


DE LAVAL HIGH EFFICIENCY STEAM DRIVEN AUXILIARIES

for High Rating Boilers



Two 1250 hp. multistage turbines with multi-nozzle control to drive boiler feed pumps for same plant.



1200 hp. multistage geared turbine to drive mechanical draft fans; one of two units for the same plant.

Steam driven boiler room auxiliaries confer valuable advantages.

1. They can be operated independently of the main units and of the electrical system, and even on reduced steam pressure.
2. They are reliable, by reason both of their simple, sturdy construction and of their immunity to electrical disturbances.
3. They do not subtract from, and hence are not chargeable with, the capacity of main units, including transformers, switching gear and cables.
4. They can be directly and accurately regulated as to both speed and output. Turbine driven draft fans, for example, do not require supplementary damper regulation.
5. DE LAVAL TURBINE DRIVEN AUXILIARIES are adapted to receive steam directly from the station steam mains and can be designed to operate efficiently in bleeder, back pressure or condensing service. In large plants their efficiency may approximate the overall efficiency, including generators, transformers and motors, of electric driven auxiliaries.
6. The De Laval Double Helical Speed Reducing Gear makes possible the attainment of maximum efficiency in both turbine and driven machine.

These advantages may be best demonstrated by application to a specific case. If you will send data concerning the requirements for auxiliary power in your plant, our engineers will gladly submit suggestions, with estimate, for the most economical layout.

3511

DE LAVAL STEAM TURBINE CO. . . TRENTON, N. J.

Power Plant Construction News

Ala., Mobile—Southern Kraft Corporation plans installation of electric power equipment in connection with expansion and improvements in kraft paper mills. Entire project will cost about $200,000. Company is a subsidiary of International Paper Co., 220 East Forty-second Street, New York, N. Y.

Ark., Crossett—Crossett Paper Mills, Inc., plans installation of new turbo-generator, boiler unit and auxiliary equipment for expansion in power house. Also will install electric power equipment for mill service in connection with extensions and improvements in kraft paper mills. Entire project will cost close to $750,000 and will be carried out over a period of months. K. A. Forrest is general manager.

Colo., Lamar—City Council has plans nearing completion for expansion and improvements in municipal electric power plant, including installation of a 2000-kw. steam turbo-generator unit and accessories, boiler and auxiliary equipment. Cost about $242,500, of which $109,148 is being secured through a Federal grant.

Del., Seaford—E. I. duPont deNemours & Co., Inc., Rayon Division, duPont Building, plans installation of electric power equipment in new mill on 340-acre tract of land near Seaford, recently acquired. Plant will consist of several large units. A power house will be built. Entire project will cost about $7,500,000 and is scheduled for completion late in 1939. Company engineering department, address noted, is in charge.

Idaho, Bonners Ferry—City Council plans new municipal hydroelectric power plant. Cost about $300,000, of which $134,364 is being arranged through a Federal grant. G. A. Pehrson, Old National Bank Building, Spokane, Wash., is architect.

Ill., Chicago—Commonwealth Edison Co., 72 West Adams Street, is arranging an appropriation of about $25,000,000 to be used for expansion and improvements in plants and system over a 24-month period, including installation of high-pressure boilers, steam turbo-generators and auxiliary equipment to increase present capacity of plants by more than 125,000-kw.; power substation units; transmission and distributing lines, and other facilities.

Ill., Chicago—J. H. Stone & Sons, 1851 West Seventy-fourth Street. plan installation of electric power equipment in new one-story paper box-manufacturing plant in Central Manufacturing District. A crane and other mechanical-handling equipment will be installed. Entire project will cost about $500,000. A. Epstein, 2001 West Pershing Road, is engineer.

Ill., Joliet—Joyce 7-Up Co., Inc., plans installation of electric power equipment in new two-story beverage bottling plant on local site. Entire project will cost about $250,000. Work is scheduled to begin soon. J. M. Joyce is president, in charge.

Iowa, Cascade—City Council has plans under way for new municipal electric power plant. Proposed to use Diesel engine-generator units and accessories. Cost about $110,000, of which $49,500 will be a Federal grant. Young & Stanley, Inc., Muscatine, Iowa, is consulting engineer.

Iowa, Lamoni—City Council will receive bids until Dec. 6 for new municipal electric power plant, including station building, cooling tower base and oil tanks (Section 1); two Diesel engine-generator units and auxiliary equipment with combined capacity of 600-hp., and alternate bids for units of 525-hp. rating (Section 2); electrical equipment (Section 3); and complete distributing system (Section 4). Young & Stanley, Inc., Muscatine, Iowa, is consulting engineer.

Kan., Dodge City—Shore Machine Works, A. D. Shore, head, plans installation of electric power equipment in connection with rebuilding of portion of plant, recently destroyed by fire. Loss estimated over $80,000.

Minn., Preston—City Council has plans for additions and improvements in municipal electric power plant, including installation of new generating unit, cooling tower and accessory equipment. Cost about $46,200, of which $20,900 is being secured through a Federal grant. G. M. Orr & Co., Baker Arcade Building, Minneapolis, Minn., are consulting engineers.

Mo., St. Louis—Lincoln Engineering Co., 5701 Natural Bridge Avenue, manufacturer of lubricating oil apparatus, etc., plans installation of electric power equipment in new one-story addition to plant. Entire project will cost close to $60,000. Frank S. Barks is president.

Neb., York—City Council will receive bids until Dec. 9 for new municipal electric power plant, including complete equipment. Also for an electrical distributing system and operating facilities. Cost about $425,000. Financing has been arranged through Federal aid. C. Robert Fulton and Bruce Hazen, 2327 South Nineteenth Street, Lincoln, Neb., are consulting engineers.

N. J., Grenloch—Grenloch Tapestry Mill, William Taylor, head, plans installation of electric power equipment in connection with proposed rebuilding of portion of three-story textile mill recently destroyed by fire. Loss about $50,000.

N. M., Tucumcari—City Council, J. M. Stark, city clerk, has plans under way for new municipal electric power plant, using Diesel engine-generating units and accessories. Cost about $416,000, of which $187,363 will be secured through Federal aid. A portion of appropriation will be used for an electrical distribution system. Powell & Goldenberg, 127 East Water Street, Santa Fe, N. M., are consulting engineers.

N. Y., Jamestown—Hope's Windows, Inc., Hopkins Avenue, plans installation of electric power equipment in new one-story addition to metal window casement plant, 100x400 ft. Entire project will cost about $100,000. Beck & Tinkham, Bailey Building, are architects.

N. C., Greensboro—Carter Fabrics Co. plans installation of electric power equipment in new one-story addition to textile mill, 65x135 ft. Entire project will cost over $60,000. Charles C. Hartmann, Jefferson Building, is architect.

N. C., Henderson—Corbitt Co., manufacturer of automobile bodies, plans installation of electric power equipment in connection with rebuilding of portion of plant, recently destroyed by fire. Loss estimated close to $70,000.

N. C., High Point—City Council has plans nearing completion and will take bids soon for new municipal hydroelectric power plant on Yadkin River, near Winston-Salem, N. C. Entire project, including transmission lines, power substations and other structures will cost close to $6,500,000. Financing has been arranged through Federal aid. Murray & Flood, Inc., 369 Lexington Avenue, New York, N. Y., is consulting engineer.

Ohio, Columbus—Columbus Packing Co., 1976 South High Street, meat packer, a subsidiary of Armour & Co., Union Stock Yards, Chicago, Ill., plans installation of electric power equipment in connection with expansion and improvements in plant, to be carried out during the coming year. Cost about $250,000. Work will be in charge of engineering department of parent company.

Ohio, East Liverpool—City Council is completing plans for complete electrification of municipal waterworks pumping station, including installation of new equipment. Cost estimated at $66,000. Financing is being arranged through Federal aid. Chester Engineers, Inc., Century Building, Pittsburgh, Pa., is consulting engineer.

Ohio, Mansfield—Mansfield Tire & Rubber Co., manufacturer of automobile tires, tubes, etc., plans installation of electric power equipment in new two-story addition to plant. Entire project is reported to cost over $50,000. Proposed to begin work soon.

Ohio, Wellston—Department of Public Service, H. R. Lasley, director, plans extensions and improvements in municipal light and power plant, including installation of additional equipment. Cost estimated close to $200,000. Financing is being arranged through Federal aid. F. W. C. Bailey, 20 South Third Street, Columbus, Ohio, is consulting engineer.

S. C., Georgetown—American Cyanamid & Chemical Corporation, 30 Rockefeller Plaza, New York, N. Y., plans installation of electric power equipment in new plant on 72-acre tract of plant recently acquired at Georgetown, to be used for production of sulphate of alumina and kindred chemical specialties. Entire project is reported to cost over $400,000.

Texas, Goldthwaite—City Council has plans under way for new municipal electric power plant and electrical distribution system. Proposed to use Diesel engine-generating units and accessory equipment. Cost about $125,000. Financing is being arranged through Federal aid. William G. Morrison, Professional Building, Waco, Tex., is consulting engineer.

DESUPERHEAT as these fine plants do it!

Carbide & Carbon Chemicals Corp. • Monongahela West Penn Public Service Co. • Franklin Sugar Refining Co. • Shell Oil Company • Central Maine Power Co. • Ford Motor Co. of Canada • Standard Oil Co. of Calif. U. S. Rubber Co. • Owens-Illinois Glass Co. • Pillsbury Flour Mills Co. Tide Water Oil Co. • Carnegie-Illinois Steel Corp. • Hercules Powder Co. W. Va. Pulp & Paper Co. • Great Lakes Steel Corp. • Procter & Gamble Co. Western Electric Co. • U. S. Industrial Alcohol Co. • Bethlehem Steel Co. American Tobacco Co. • Container Corp. of America • Andrew Jergens Co. Morton Salt Co. • Alpha Portland Cement Co. • General Electric Co. Barrett Company • Taylor Instrument Companies • Champion Fibre Co. Armstrong Cork Co. • National Biscuit Company • Packard Motor Co. Norwich Chemical Co. • West Penn Power Co.

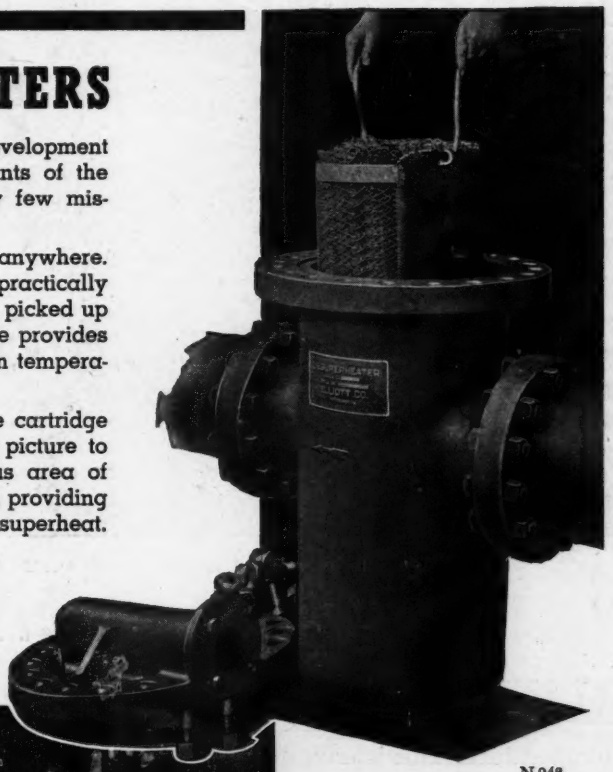
ELLIOTT DESUPERHEATERS

have been increasingly favored since their development 14 years ago. They *must* be right, since plants of the character of those listed above make mighty few mistakes in equipment selection.

These units can be placed in a pipe line anywhere. Water supply can be controlled so there is practically no drain loss. The design prevents water being picked up and carried over with the steam. Water storage provides stability for handling varying loads, changes in temperature and pressure.

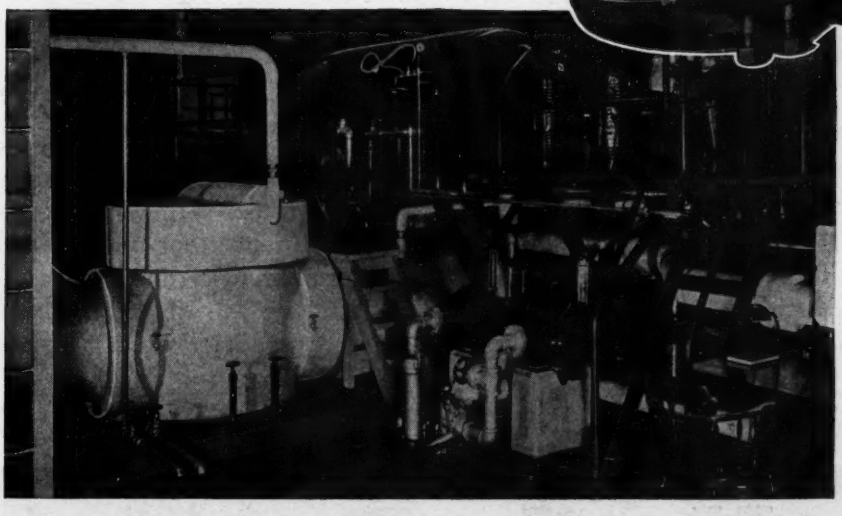
Easy cleaning is a strong feature — note the cartridge being withdrawn from the unit shown in the picture to the right. The cartridge presents an enormous area of mat surface to which water clings in a thin film, providing efficient evaporation of water and removal of superheat.

Built in all required sizes, and for total or partial desuperheating.



N-948

Below: 24-in. Elliott desuperheater handling exhaust of turbine shown in background. Another desuperheater—10-in.—handles steam bled from the turbine.



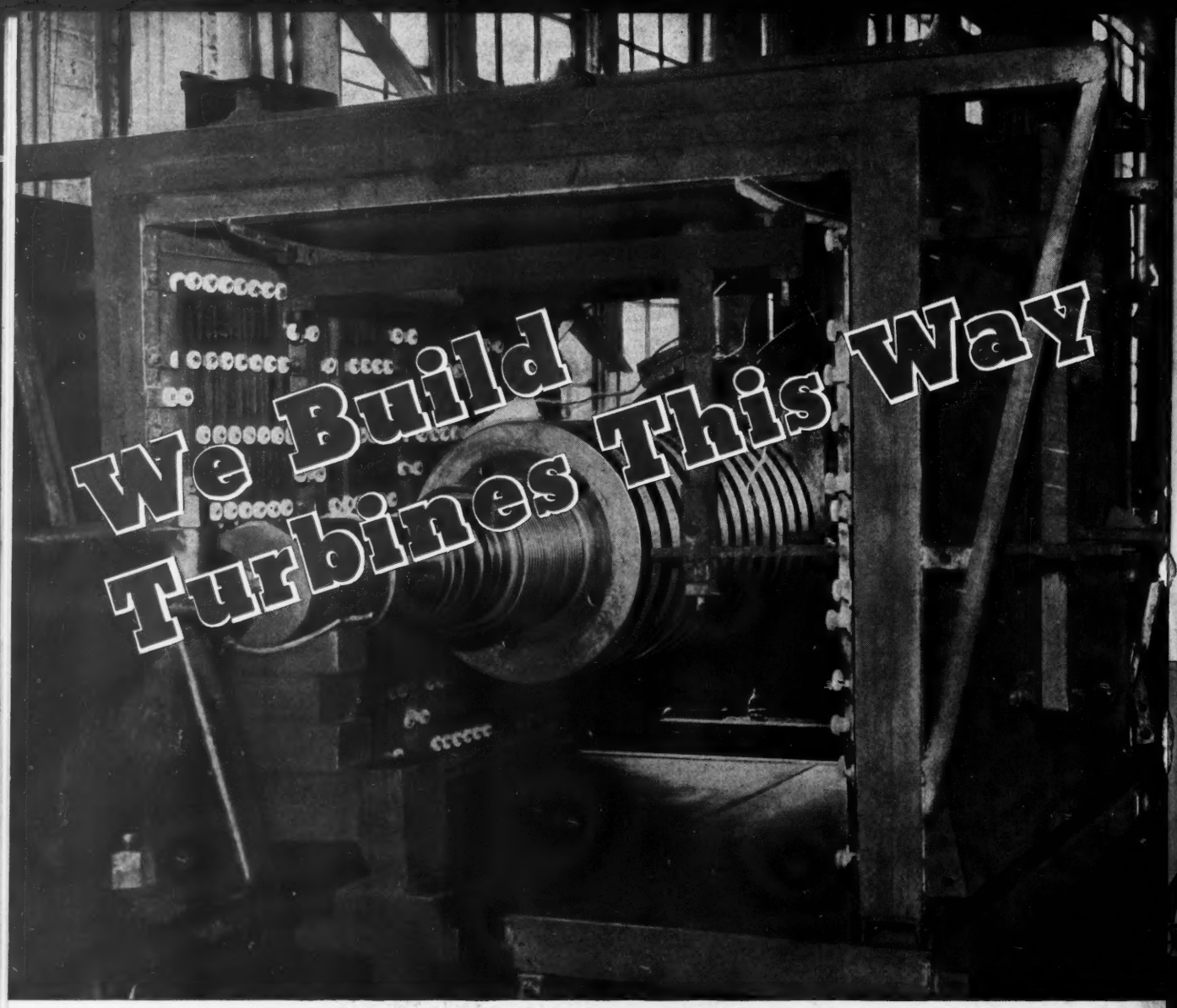
ELLIOTT COMPANY

Accessories Dept.

JEANNETTE, PA.

District Offices in Principal Cities

Published monthly by the Technical Publishing Co., at 53 West Jackson Blvd., Chicago. Subscription price $2.00 a year. Single copies current issue, 25c. Entered as second class matter September 8, 1932, at the Post Office, Chicago, Ill., under act of March 3, 1879. Vol. XLII, No. 12.



A glimpse into the world's largest turbine workshop

HEAT TESTING

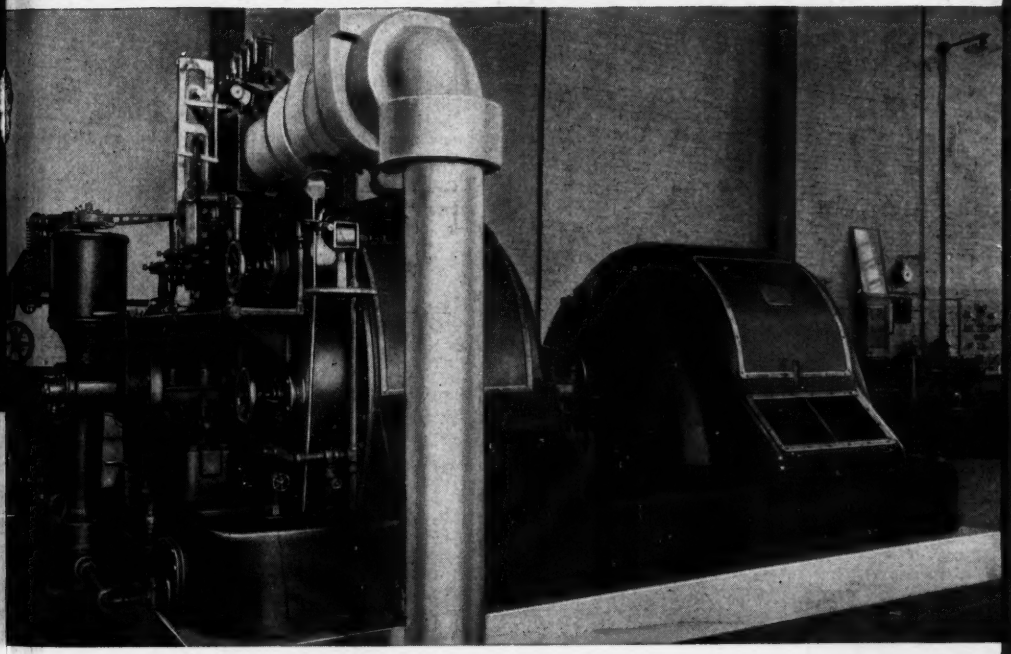
EACH General Electric turbine shaft is heat-tested to check deflection at high temperature. This is an important test. Turbine shafts must run true. Like other checks in the turbine factory, this test measures performance. The outstanding operating records of G-E turbines have been made possible by such rigorous checks and tests.

This electric oven heats the turbine shaft slowly and uniformly. The shaft rotates at low speed throughout the test. As the temperature rises, sensitive instruments record deflection. Maximum allowable deflection at the end of the test is 1/1000 inch. Results have shown that the deflection will not increase with repeated heating. If the shaft passes this test, normal temperature stresses will not cause it to deflect in service.

The shaft heat test is but one of the manufacturing tests which G-E turbines must pass. Each adds to the assurance that the completed turbine will perform in accordance with G-E standards. The results of experienced design and skilled manufacture and test are a matter of record.

For Records Like This!

Twenty-three Years of SERVICE Smooth and Economical Today Total Maintenance—$175



Twenty-three years of low-cost, reliable service is the record of this G-E turbine-generator

This 750-kw G-E turbine-generator has been on the job nine hours a day, five to six days a week, for more than twenty-three years. Operation is so smooth that a coin can be balanced on edge on the turbine casing during operation. Economy is still good, as shown by checks with original water rates. Maintenance has been unusually low.

We know that performance like this will interest you. The turbine specialist at the nearest G-E office will be glad to give additional information. He can assist you in selecting the correct equipment for your plant. General Electric, Schenectady, N. Y.

ATTENTION, POWER ENGINEERS

Here's real news—an inkless electric recording instrument that offers these four outstanding advantages:

NO INK TO SPILL

The inkless system prevents soiled hands and clothing. There's no blotting or flooding of ink on the record rolls under fluctuating loads.

IMPROVED RELIABILITY

The pen has been replaced by a stylus. This eliminates inking failures due to evaporation of the ink or a clogged system.

REDUCED MAINTE-

Just install the record roll. There is no pen to inkwell to clean—no job to purchase—no pen to clean.

LOW-TEMPERATURE OPERATION

This new instrument gives successful operation down to —40 F.

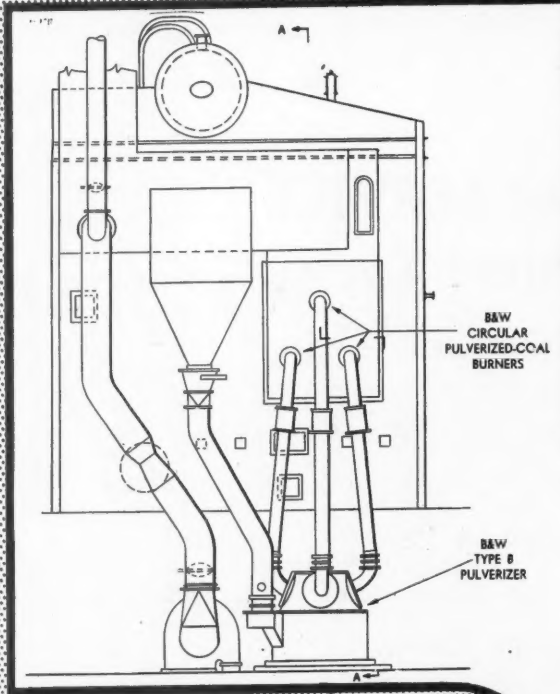
You can obtain complete information on this new inkless recorder from your nearest G-E office. Or write General Electric Co., Dept. 43-201, Schenectady, N. Y., for Bulletin GEA-3010.

GE

ELECTRIC

4 B & W Integral

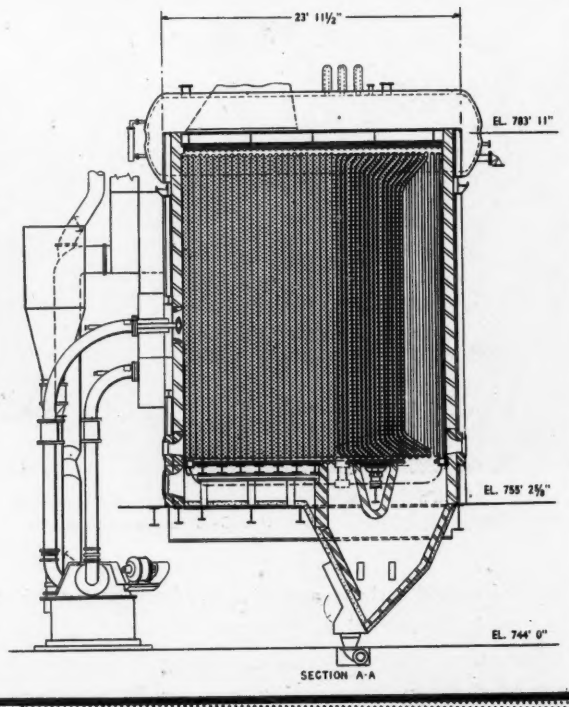
TRADE MARK REG. U.S. PAT. OFF.

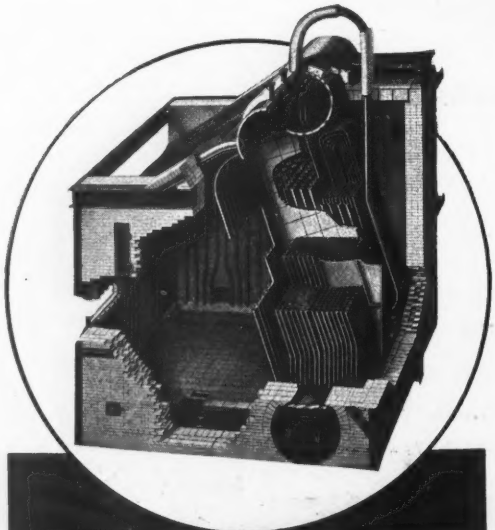


DATA . . .

4 Integral-Furnace Boilers installed in 1936.
Capacity Each, Max. Continuous, 125,000 lb. steam per hour.
Operating Steam Pressure, 160 lb. per sq. in. initial.
Operating Steam Pressure, 425 lb. per sq. in. ultimate.
Pulverized-coal fired by one B&W Pulverizer per boiler.
Fuel: Bituminous coal.

General arrangement of boiler interior is shown by the cut-away perspective view at lower left. Section A-A, immediately below, shows the construction of the furnace with hopper bottom.





BABCOCK &

POWER PLANT ENGINEERING

Furnace Boiler Units

Pay 22% Dividends
for
Automobile Manufacturer

Coal costs were cut nearly $80,000 per year and steam output per square foot of floor space doubled with four B & W Integral-Furnace Boilers. Annual savings realized by the new units, which replaced old stoker-fired boilers are equivalent to 22 per cent of the entire investment for boilers and associated equipment—delivered and installed.

B & W Integral-Furnace Boiler Units are also making worth while savings for a university, a laundry, and a water supply company; as well as cutting costs for producers of steel, soap, paper, and glue. More than 200 of these units have been installed—many of them representing repeat orders.

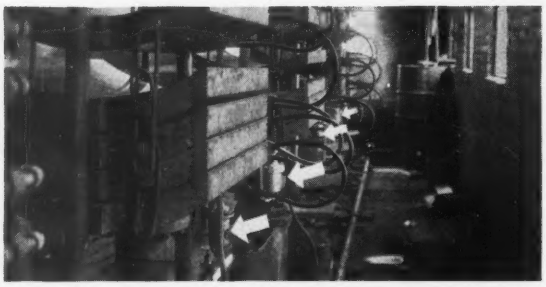
Details gladly furnished upon request.

THE BABCOCK & WILCOX COMPANY
85 LIBERTY STREET . . . NEW YORK, N. Y.

G-142-T

& WILCOX *Sent* **UPON REQUEST**

HOW YOU CAN



WOOD WORKING PLANT

Bending chair backs formerly took sixty minutes press time at the Union Chair Co., Union City, Pa. With Armstrong traps installed, this time was cut to thirty minutes. It was particularly fortunate that this increase in production capacity came just when the Union Chair Co. needed it most.

CANDY MAKER

The Nutrine Candy Co. of Chicago needed more capacity. A test was made with Armstrong Unit Trapping and new return lines. On the crystallizers shown above, cooking time was cut as much as 14% per batch. Subsequently, a total of 64 Armstrong traps were put in and one boiler now handles the load that formerly kept two busy.

GREENHOUSE

Recently, the Pittsburgh Cut Flower Co. changed over a rose house to No. 200 and 201 Armstrong traps for draining individual heating coils. These traps are now given credit for increasing bloom production 38% by eliminating harmful irregularities in temperature.

BOX BOARD MILL

When originally installed in the Bradford, Pa., mill of the Northeastern Container Corp., the big corrugating machine shown here was equipped with one trap per section of drying plates. In order to get results, the crew had to open up by-passes that wasted a lot of steam. Now, with a No. 211 Armstrong trap on each plate, temperatures are uniformly higher, production has increased, and steam consumption has been greatly decreased.

Change over to ARMSTRONG

INCREASE OUTPUT *without adding more equipment*

HERE is an idea that is paying big dividends to users of steam in all branches of industry: ARMSTRONG UNIT TRAPPING! By putting individual Armstrong traps on each chest . . . coil . . . header . . . or roll, you will be positively insuring against water-logging . . . short-circuiting . . . air-binding . . . and sluggish drainage! In addition, you will also be stopping wasteful steam leaks and preventing dissipation of pressure needed to maintain desired temperatures.

Examples of benefits being secured by some of the typical users appear on the opposite page. In the above picture, individual Armstrong traps can be seen draining big retorts in one of Chicago's largest packing plants—84 traps for 84 retorts! This also was a case where maximum output has been combined with minimum steam consumption.

Armstrong traps are offered in a complete range of sizes for any pressure. And in each one you get the long-life Armstrong inverted bucket operating mechanism. Get the traps you need now. Catalog free on request.

ARMSTRONG MACHINE WORKS
810 Maple St., Three Rivers, Mich.

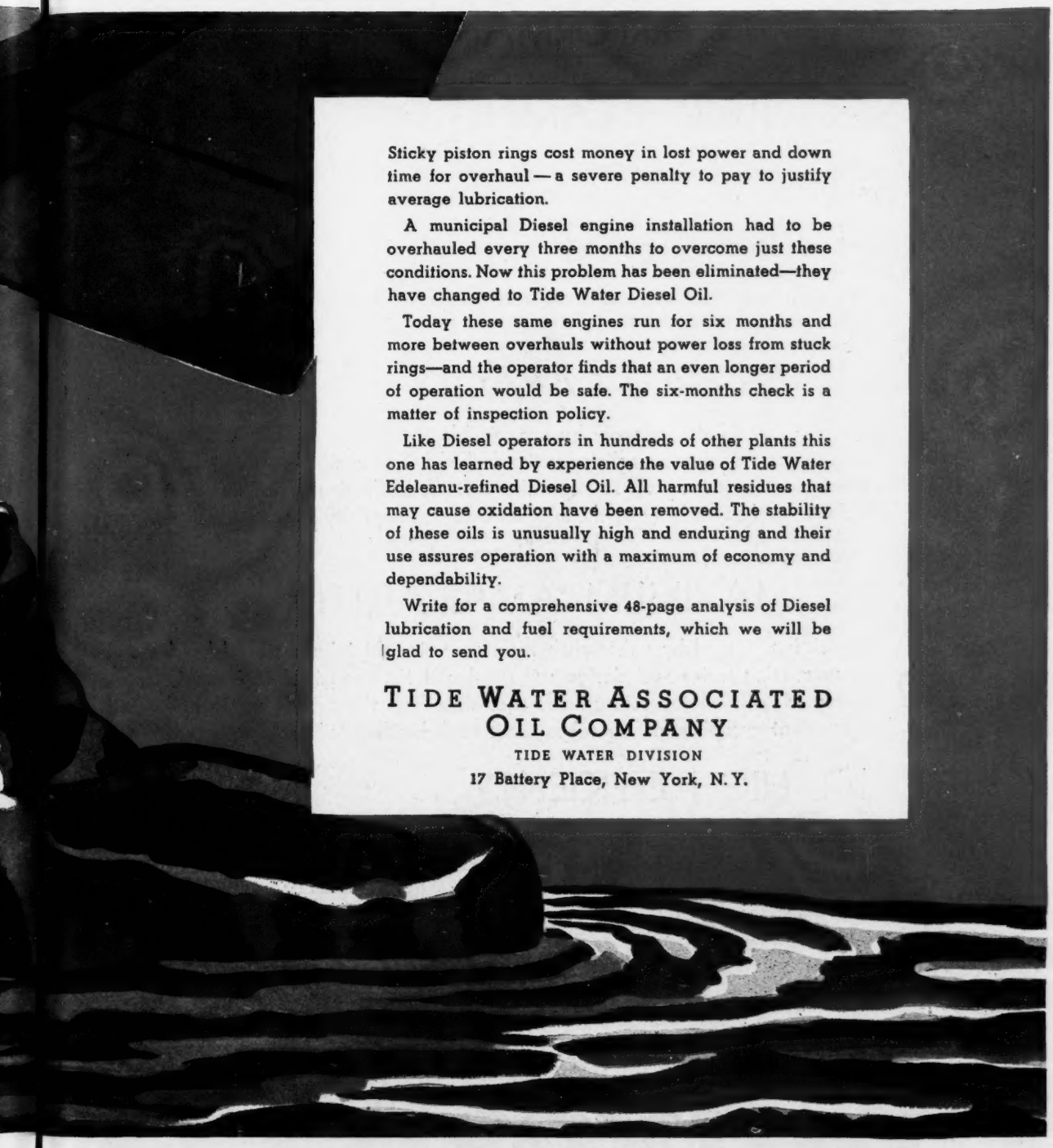
UNIT TRAPPING

PISTONS USED TO STICK

TIDE WATER

THERE IS A COMPLETE LINE OF TYCOL LUBRICANTS

LIKE RUBBERS IN MUD



Sticky piston rings cost money in lost power and down time for overhaul — a severe penalty to pay to justify average lubrication.

A municipal Diesel engine installation had to be overhauled every three months to overcome just these conditions. Now this problem has been eliminated—they have changed to Tide Water Diesel Oil.

Today these same engines run for six months and more between overhauls without power loss from stuck rings—and the operator finds that an even longer period of operation would be safe. The six-months check is a matter of inspection policy.

Like Diesel operators in hundreds of other plants this one has learned by experience the value of Tide Water Edeleanu-refined Diesel Oil. All harmful residues that may cause oxidation have been removed. The stability of these oils is unusually high and enduring and their use assures operation with a maximum of economy and dependability.

Write for a comprehensive 48-page analysis of Diesel lubrication and fuel requirements, which we will be glad to send you.

TIDE WATER ASSOCIATED
OIL COMPANY
TIDE WATER DIVISION
17 Battery Place, New York, N. Y.

DIESEL OIL

SCIENTIFICALLY ENGINEERED FOR EVERY INDUSTRIAL USE

WE CAN GIVE YOU

IN PERFORMANCE

YOU WANT **QUICK STEAMING**

Which is provided by our small size tubes arranged for most efficient heat absorption

YOU WANT **DRY STEAM**

Which is provided by · our cross drum arrangement · large drum size · steam delivery all above the water level · efficient internal drum baffling

YOU WANT **ASSURED CAPACITY**

Which is provided · primarily by our careful attention to correct furnace design with adequate furnace cooling for the fuel and load conditions, using close tube spacing in the water walls to insure the continued effectiveness of this absorption surface · and secondarily by the inherent overload capacity of the cross drum type boiler

YOU WANT **MAXIMUM AVAILABILITY**

Which is provided by · the reliability of our straight tube sectional header and close spacing water wall design · the reduced time required to inspect, clean, or repair · with all generating tubes accessible from the outside of the boiler and convenient grouping of four tubes under each handhole plate

YOU WANT **HIGH EFFICIENCY**

Which is provided by our three pass cross flow of gases over staggered groups of three inch tubes, effectively breaking up the gas stream, assuring contact between the hot gases and the tubes and resulting in exceptionally low exit gas temperature in everyday operation

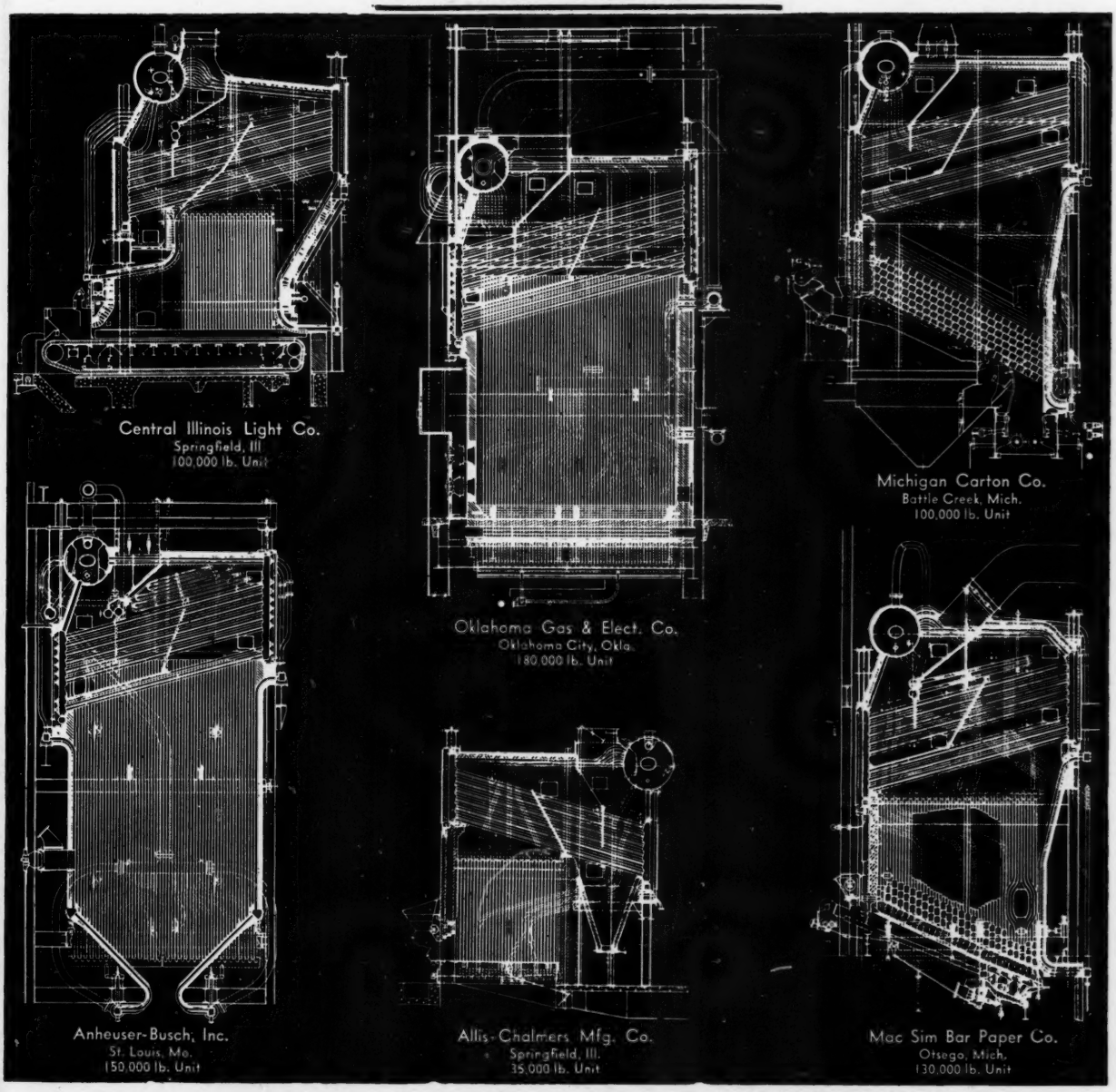
YOU WANT THE EXTRA SAVINGS MADE POSSIBLE BY THE DEPENDABLE PERFORMANCE OF A MODERN UNIT OF THE MOST RELIABLE TYPE

INVESTIGATE THE ADVANTAGES OF SPRINGFIELD EQUIPMENT

SPRINGFIELD BOILERS & WATER WALLS

WHAT YOU WANT

IN ARRANGEMENT



Central Illinois Light Co.
Springfield, Ill
100,000 lb. Unit

Oklahoma Gas & Elect. Co.
Oklahoma City, Okla.
180,000 lb. Unit

Michigan Carton Co.
Battle Creek, Mich.
100,000 lb. Unit

Anheuser-Busch, Inc.
St. Louis, Mo.
150,000 lb. Unit

Allis-Chalmers Mfg. Co.
Springfield, Ill.
35,000 lb. Unit

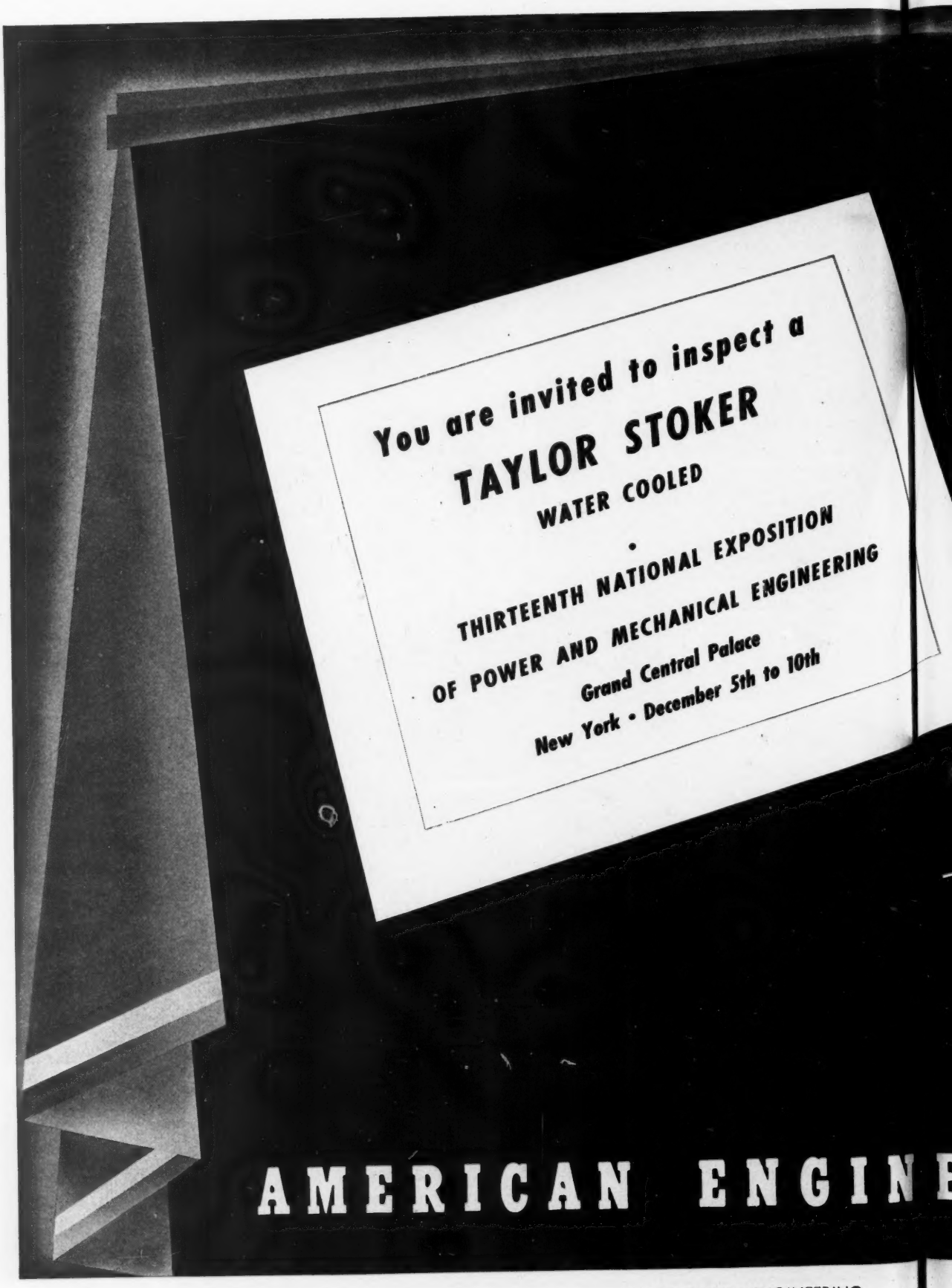
Mac Sim Bar Paper Co.
Otsego, Mich.
130,000 lb. Unit

EASILY ADAPTED TO ANY FUEL OR ANY FIRING METHOD

SPRINGFIELD BOILER CO.

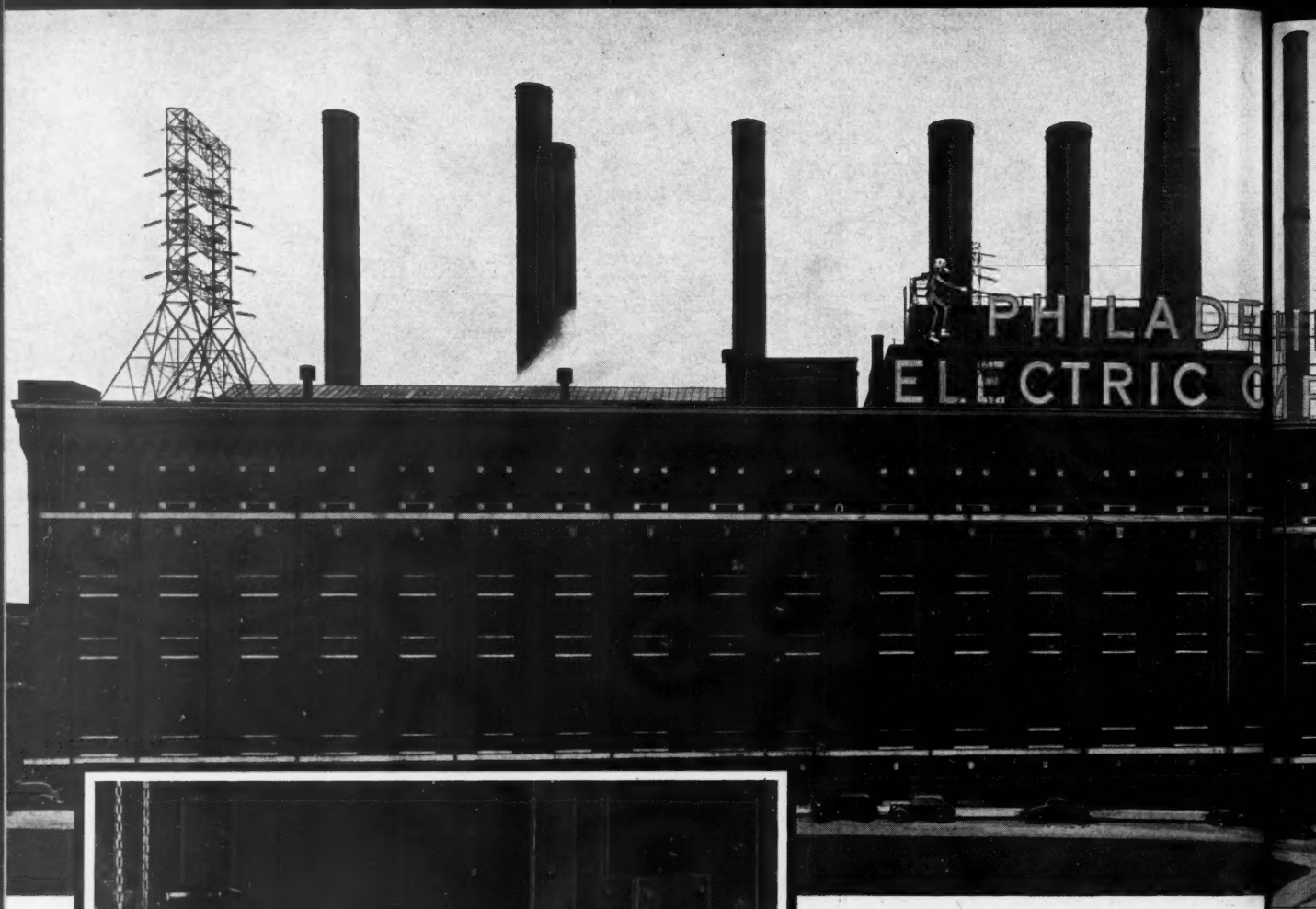
SPRINGFIELD, ILLINOIS

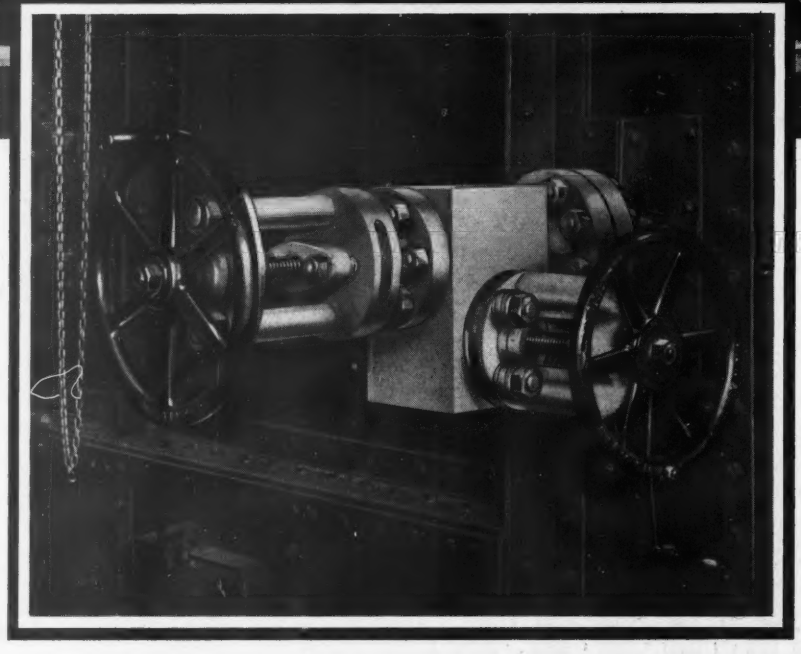
CHICAGO PHILADELPHIA DALLAS OSWEGO CINCINNATI BATON ROUGE
NEW YORK BOSTON DETROIT PITTSBURGH MINNEAPOLIS MEXICO CITY


You are invited to inspect a
TAYLOR STOKER
WATER COOLED
•
THIRTEENTH NATIONAL EXPOSITION
OF POWER AND MECHANICAL ENGINEERING
Grand Central Palace
New York • December 5th to 10th
AMERICAN ENGINE

NEERING COMPANY

460 Yarway Valves





Above: General view of Schuylkill Station of the Philadelphia Electric Co.

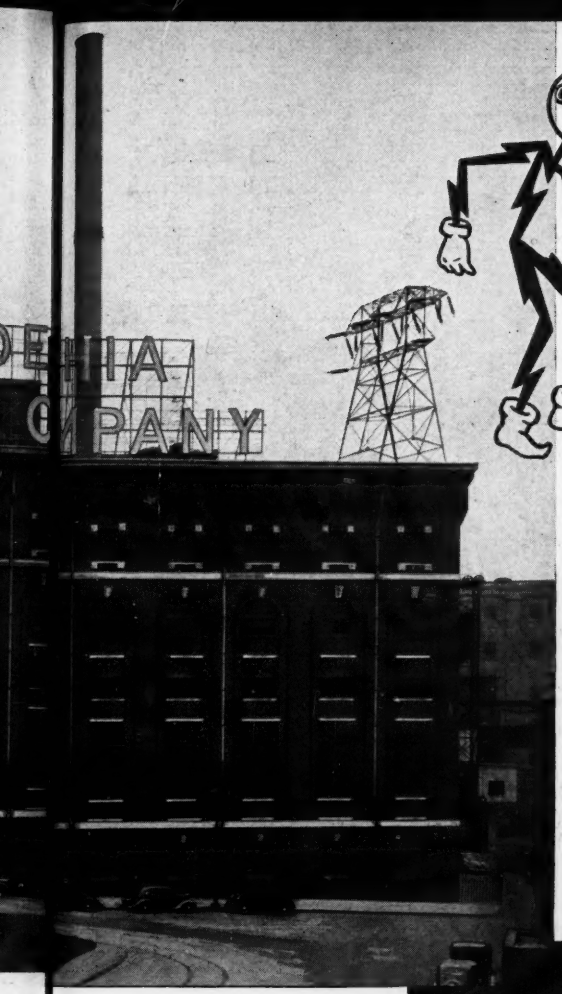
•

At left: One of the four rugged Yarway Forged Steel Unit Tandem Blow-Off Valves on the main lower drums at Schuylkill Station.

SEE OUR EXHIBIT
Booth No. 66, Power Show, Grand Central Palace, New York City, Dec. 5 to 10, 1938

YARWAY

at Philadelphia Electric



For Schuylkill Station's two new 1400 lb. pressure steam generating units—latest addition to this important system—Philadelphia Electric has again selected Yarway Blow-Off Valves, 28 forged steel valves in all.

Four of these valves are Yarway Unit Tandems used on main blow-down lines. Sixteen are Yarway Seatless Valves in tandem with eight Yarway Hard-Seat Valves used on water wall drain lines. All are the most modern types with flanged inlet and welding outlet connections.

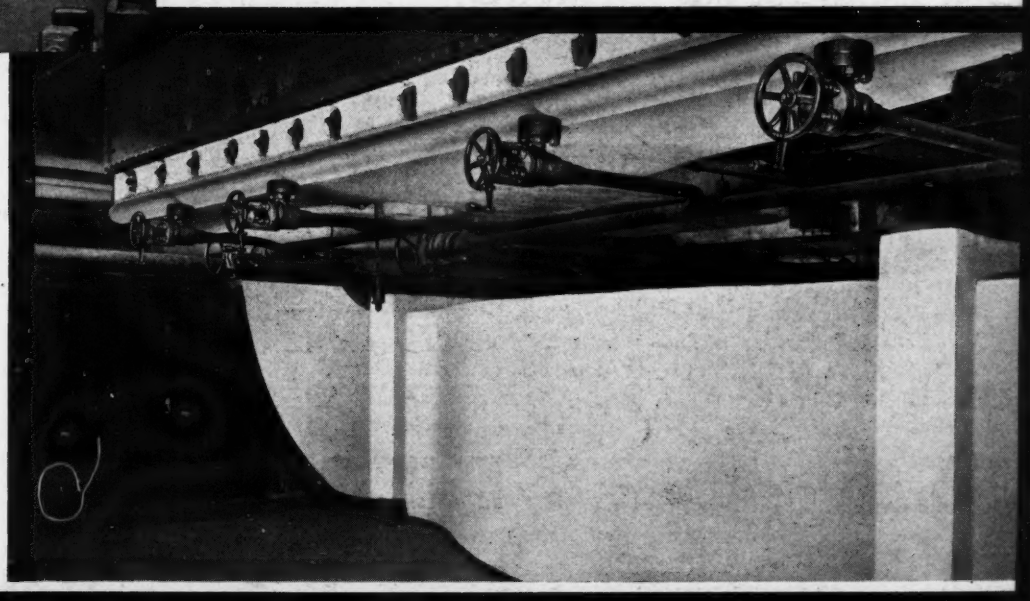
Philadelphia Electric first bought Yarway Valves 23 years ago and have reordered Yarways many times since then, for Richmond, Delaware, Chester and Schuylkill Stations, as load requirements have necessitated new plants and extensions to keep "Ready Kilowatt" ready for any demand.

Maintenance cost of these valves has been unusually low and the original valves purchased are still in service.

The experience of more than 12,000 Yarway Blow-Off Valve users—many, like Philadelphia Electric's, extending back over a quarter-century of service—are positive assurance of your satisfaction when you select Yarway Valves for your requirements on low, medium or high pressure service (up to 2,500 lbs.).

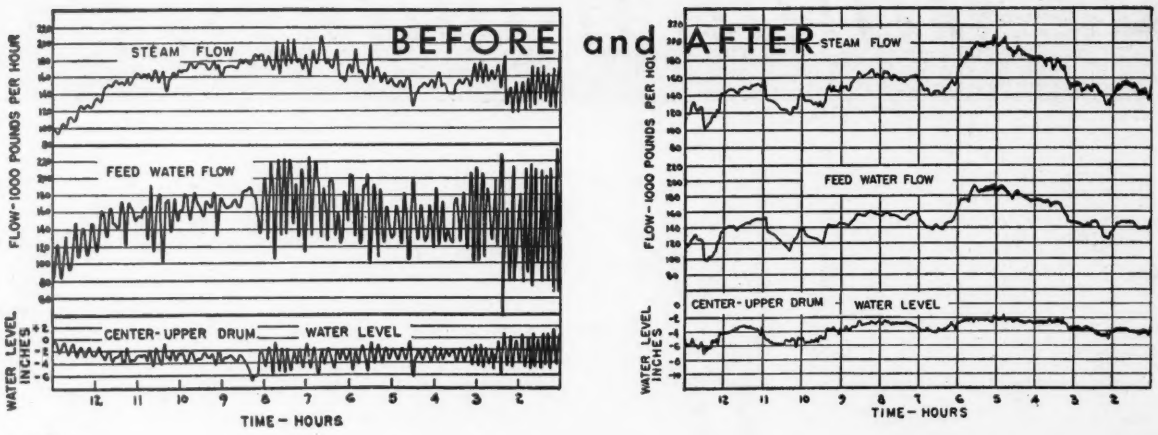
Ask for Catalog. Section B-420, up to 400 lbs. pressure. Section B-430, for higher pressures.

YARNALL-WARING COMPANY
114 Mermaid Avenue Philadelphia

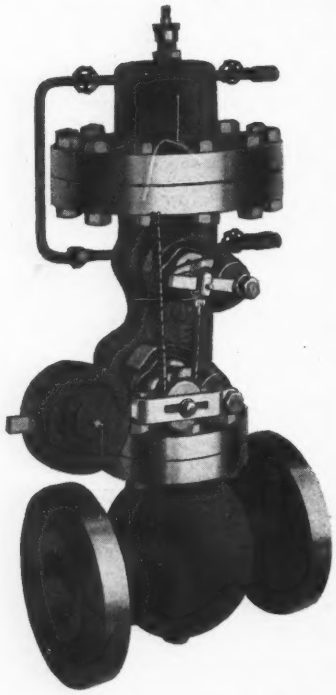


Yarway Forged Steel Seatless and Hard-Seat Valves on water wall drains. There are 16 Yarway Seatless and 8 Hard-Seat Valves on water walls at Schuylkill Station. Note flanged inlet and welding outlet connections on all these valves.

BLOW-OFF VALVES



Charts prove value of steam-flow type COPES *feed water control.*



There's no guesswork about results when you use COPES steam-flow type feed water regulators. You can check more than 100 installations. For example, study these charts — produced under identical turbine conditions. Note how COPES smoothed out the curves for steam flow, water flow and boiler water level. May we send you Bulletin 409, describing the new COPES Flowmatic — the most modern steam-flow type feed water regulator?

NORTHERN EQUIPMENT CO., 1212 GROVE DRIVE, ERIE, PA.
Feed Water Regulators, Pump Governors, Differential Valves, Liquid Level Controls, Reducing Valves and Desuperheaters.
BRANCH PLANTS IN CANADA, ENGLAND, FRANCE, GERMANY, AUSTRIA AND ITALY. REPRESENTATIVES EVERYWHERE.

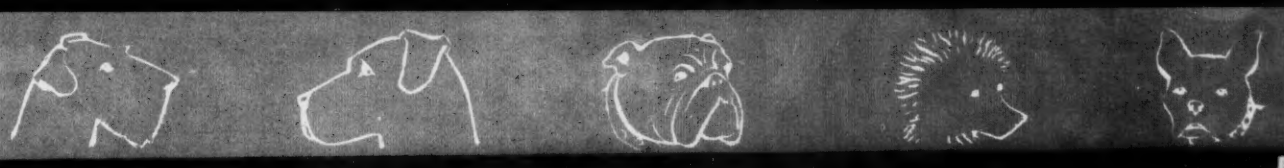
Get closer boiler water level control with the new

COPES

FEEDS BOILER ACCORDING TO STEAM FLOW•AUTOMATICALLY

FLOWMATIC

★ REGULATOR



STEAM TRAPS HAVE INDIVIDUALITY *too!*

The quickest way to save steam and improve production conditions is to be sure that the right steam trap is in the right spot, on every job.

Look at the five kinds of traps at the right — all different in appearance and size. And each one is designed for a specific function which none of the others can perform as well.

Some are highly sensitive and efficient like "retrievers", some are "bulldogs" used for handling heavy volumes of condensate rapidly, while others function like "police dogs" and provide a practical, low cost temperature control.

And any steam trap can have "distemper" and be bothersome if its mechanical construction and quality of workmanship are not equal to the task at hand.

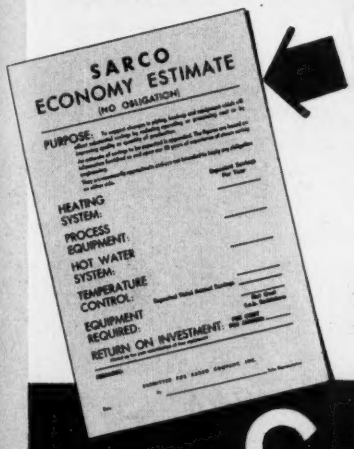
That's why the Sarco Thermostatic element, made of heavy wall bronze tubing, is so important. It is the primary or secondary actuating element on every Sarco Trap made. It has enabled Sarco Traps to succeed where others failed and it has seen service in all types of industries for a quarter of a century.

• • •

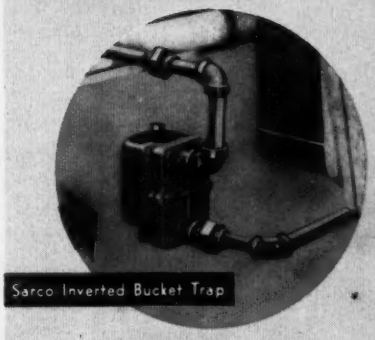
Find out the places *where* a Sarco will speed production or save steam. Find out *what* it will save and how little it will cost. No obligation. Our engineers are at your service—now.

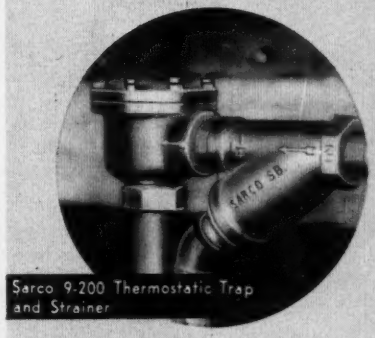
Get the "distemper" out of your steam lines now!

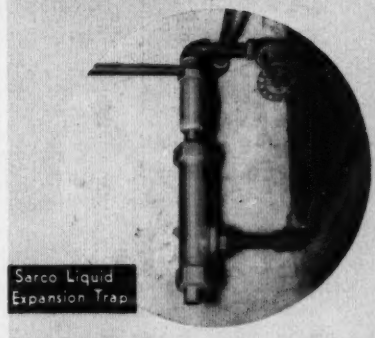
GET A SARCO ECONOMY ESTIMATE


SARCO
ECONOMY ESTIMATE
(NO OBLIGATION)
PURPOSE:
HEATING SYSTEM:
PROCESS EQUIPMENT:
HOT WATER SYSTEM:
TEMPERATURE CONTROL:
EQUIPMENT REQUIRED:
RETURN ON INVESTMENT:

Sarco No. 9 Thermostatic Trap


Sarco Inverted Bucket Trap


Sarco 9-200 Thermostatic Trap and Strainer

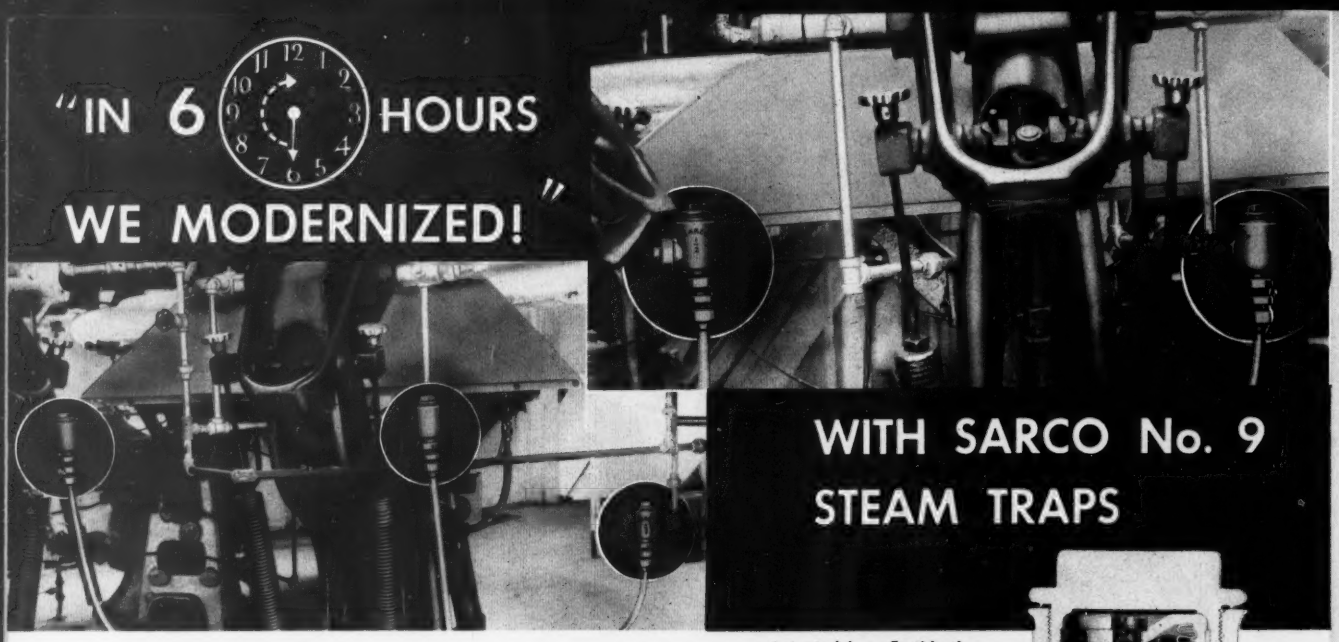

Sarco Liquid Expansion Trap

Sarco Float-Thermostatic Trap

SARCO

COMPLETE SYSTEMS FOR HEATING AND INDUSTRY

"IN 6 HOURS WE MODERNIZED!"



WITH SARCO No. 9 STEAM TRAPS

"Several months ago we decided to install Sarco Steam Traps throughout our plant in order to overcome the sluggish return system we were previously using, and thereby increase our production. In six hours one evening we installed eighteen No. 9's on our presses and miscellaneous equipment and two Float-Thermostatic Traps on our large flat-work ironer.

"Operation of our equipment has been decidedly more satisfactory from the first day the Sarco Traps were installed. The temperature of the equipment has been increased and we do not find it necessary to blow down water clogged equipment in the mornings.

"The improved operation of the machines alone has been more than worth the small investment involved, without considering the apparent fuel savings."

CAROLINE LAUNDRY, Inc., Morristown, N. J.

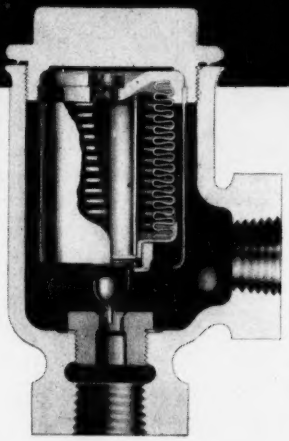
In FOOD, PROCESS, CHEMICAL . . .

and other similar industries these same Sarco Traps are speeding up and improving production at lower costs.

One reason why Sarco Steam Traps work satisfactorily where others fail is the famous Sarco Thermostatic Bellows (see illustration). Another is the fact that Sarco Traps are backed by a quarter-century of experience and that they are precision-built in a plant designed for this exclusive purpose.

• • •

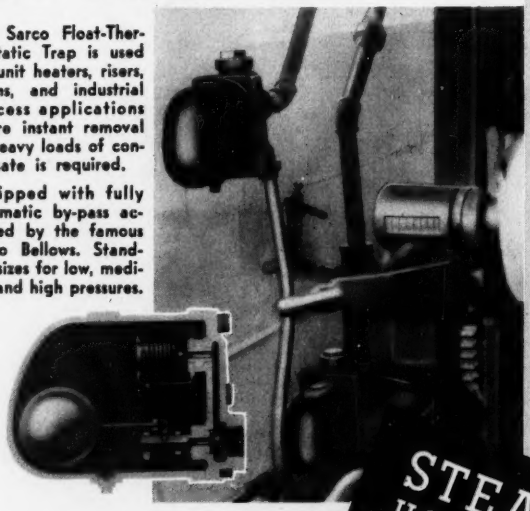
The Sarco Steam Hook-Up Book will help you decide which kinds of traps are best for your plant and how to connect them to all types of equipment. Our Representatives will provide a Sarco Economy Estimate without obligation.



Actuated by a flexible thermostatic bellows made from helically corrugated tubing. Operates satisfactorily at all pressures from 0 to maximum, without adjustment. Small, easy to install, inexpensive.

Sizes range from ½" to 2". Pressures from 0-200 lbs.

and SARCO FT'S



The Sarco Float-Thermostatic Trap is used for unit heaters, risers, mains, and industrial process applications where instant removal of heavy loads of condensate is required.

Equipped with fully automatic by-pass actuated by the famous Sarco Bellows. Standard sizes for low, medium and high pressures.

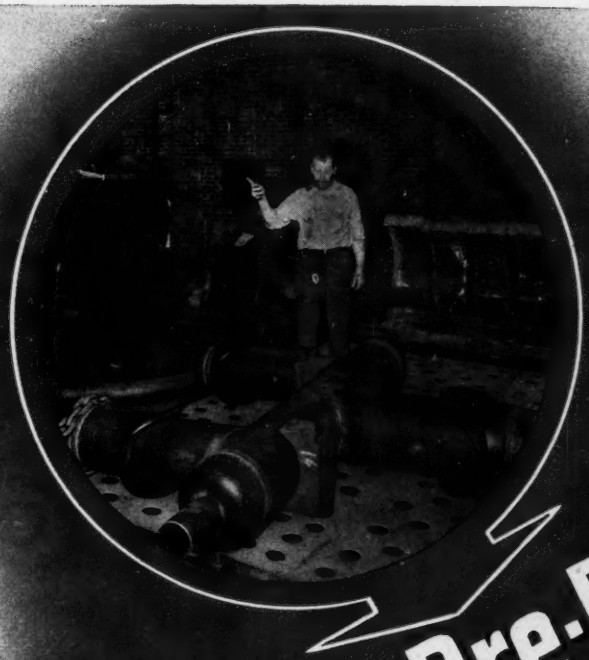
ASK FOR THIS DATA BOOK

STEAM HOOK-UPS

19-A

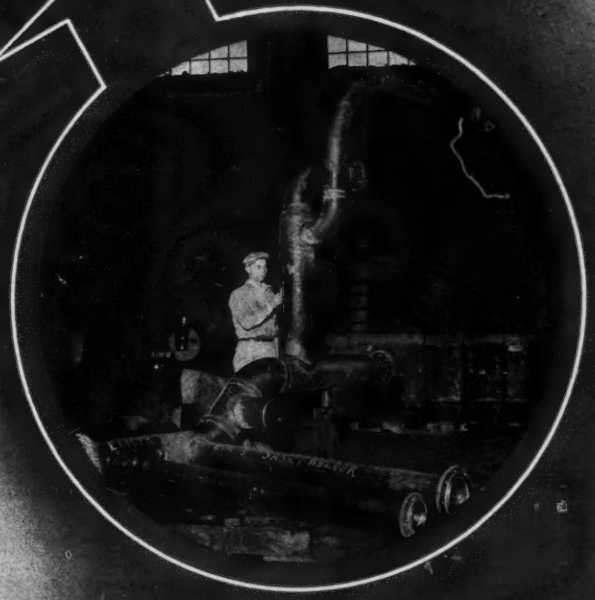
SARCO

THERMOSTATIC, FLOAT AND BUCKET TRAPS, REGULATORS AND HEATING SPECIALTIES



PIPING BY
MIDWEST

Precision Pre-Fabrication
SAVES YOU MONEY



Everybody knows that precision pays . . . that parts which fit immediately save so much money in assembly that any other kind are prohibitive in cost.

Precision in piping also pays. Piping by Midwest is pre-fabricated into a series of sub-assemblies which fit together precisely . . . which make erection a matter of relatively few field joints. Savings of time and money are obvious. In addition, the resulting piping job is superior.

Midwest Piping is pre-fabricated in modern plants, by skilled piping specialists, under controlled manufacturing conditions. Proper machinery is available to assure quality work; welders and other workmen are well trained. The work is directed by men of long experience in every type of piping.

Call on Midwest for Piping—no matter how small or how large the job.

MIDWEST PIPING & SUPPLY CO., INC.

Main Office: 1450 So. Second St., St. Louis, Mo.

Plants: St. Louis, Passaic (N. J.) and Los Angeles • Sales Offices: Chicago—946 Marquette Bldg. • Houston—1716 Second National Bank Bldg. • Los Angeles—520 Anderson St. • New York—(Eastern Division) 30 Church St. • Tulsa—332 Mayo Bldg.

"GULFCREST OIL gives

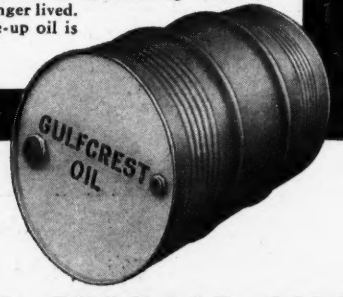
4 REASONS Why Gulfcrest Oil is the Turbine Lubricant of Unparalleled Quality

1 *Refined by the ALCHLOR Process.* This famous process, patented and owned exclusively by Gulf, is the most thorough and effective method for removing chemically active hydrocarbons as well as the general run of impurities present in all crudes.

2 *Highest resistance to oxidation.* Because this famous ALCHLOR Process synthesizes and rearranges the molecular structure of certain hydrocarbons, resulting in a finished product of greater stability, GULFCREST OIL stands alone in its high resistance to oxidation.

3 *Highest resistance to acidity and sludge.* Because of the elimination of oxidation catalysts in addition to the unparalleled refining power of the Alchlor Process, these oils form less gum and deposits, less emulsion and sludge, when mixed with water over a period of several years continuous operation, than any other turbine oil of which we have record.

4 *Highest kilowatt-hour performance.* Because Alchlor not only makes possible an oil more thoroughly refined and homogeneous but also creates antioxidants, these oils have great resistance to deteriorating influences and are longer lived. Less make-up oil is required.



ALSO A COMPLETE LINE OF FUEL AND FURNACE OILS

us better service and lasts longer!.." SAYS CHIEF ENGINEER

"In its fifth year in service in this turbine, our GULFCREST OIL is still in perfect condition. We use very little make-up oil."

Here is one important reason for the remarkable records of stability Gulfcrest is making in plants from Maine to Texas: *It has been refined and purified by Gulf's exclusive Alchlor Process!* This advanced refining method removes the bulk of the undesirable hydrocarbons and other impurities which cause oxidation and sludge formation. That is why power plant operators find that after years of service Gulfcrest shows far less deterioration than any oil they have ever used.

Operating data covering the performance of Gulfcrest Oil in major turbine installations throughout the country are verifying daily the fact that Gulfcrest is the most outstanding contribution yet made to turbine lubrication.

If you would like to know more about this advanced type of turbine oil, fill in and mail the coupon below. You will not be obligated in any way.

GULF OIL CORPORATION
GULF REFINING COMPANY
GENERAL OFFICES: GULF BLDG., PITTSBURGH, PA.

GULF INDUSTRIAL LUBRICATION

WRITE FOR THIS PAMPHLET ON GULFCREST OIL...

GULF OIL CORPORATION—GULF REFINING COMPANY
Gulf Bldg., Pittsburgh, Pa. P.P.E.

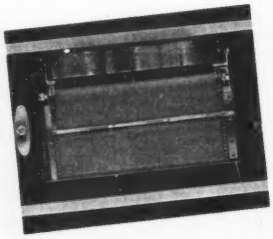
Please send me a copy of your pamphlet which discusses Gulfcrest Oil for turbine lubrication, entitled "For Civilization's Mightiest Machines."

Name.....

Company.....

Address.....

ALL ON ONE CHART



Related factors, such as steam flow, water flow, CO_2, temperatures, pressures, etc., are simultaneously recorded on one wide strip chart by the Republic multi-pen recorder. Evenly divided chart permits accurate reading at all ranges. The chart is divided into three separate zones—two pens to a zone—so that a suitable disposition of the records avoids intermingling except where it is desired—that is where they show a characteristic of operation. All records are shown by a continuous pen line of contrasting color.

SENSITIVE—POWERFUL—STABLE

Measuring the quantity it controls, regardless of application, the Smoot hydraulic or pneumatic type regulator controls pressures, flows, levels, speeds. It can be made sensitive to changes of less than 1/1000 inch of water. Operating at any required speed up to one full stroke in 2.4 seconds, it amplifies the small measured force to any necessary value. Through its powerful hydraulic or pneumatic system it applies this force to position the control device, the standard power cylinders delivering up to 5,600 foot pounds per stroke. The Smoot patented stabilizer prevents hunting by nullifying the effects of time lag in the controlled system. The regulator can be equipped for remote hand control from any distance.

COMPLETE EVAPORATION OF WATER

Control of the desuperheating water by the steam flow in the correct proportions to give the required temperature reduction with complete evaporation of the water . . . this is the important characteristic of the Smoot desuperheater.

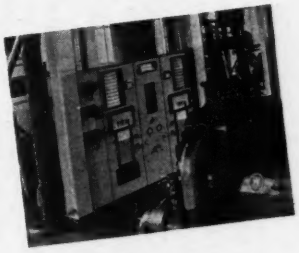
For all initial steam temperature conditions up to and including 1,000 F., and for any rate of steam flow, this desuperheater is built in the venturi and steam atomizing types. The venturi type is installed with ratio or ratio-temperature control or with a water reservoir for unusually high-speed applications. The steam atomizing type is for wide-range applications.

THE BASIS FOR ALL CO_2 MEASUREMENT

CO_2 measurement by chemical analysis is the fundamental and accepted standard against which all other methods of measuring CO_2 must be checked. This is clearly proved by the universal use of the well-known orsat apparatus as a check on CO_2 meters.

The Republic motor-driven CO_2 meter is an automatic orsat, built for continuous service under the most severe boiler-room demands. It provides a continuous pen-line record of per cent CO_2 in the flue gas measured according to the chemical method.

CO-ORDINATES BOILER OPERATIONS



Smoot automatic boiler control is adaptable to all sizes of boilers, all types of fuel firing equipment, all load characteristics and any arrangement of draft equipment.

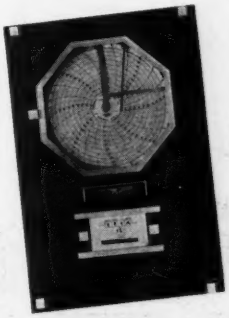
The Smoot boiler control system consists of a master controller and a group of regulators all acting in unison, each controlling a measured input quantity in a fixed ratio to the others, so as to maintain maximum combustion efficiency while holding constant steam pressure.

ONE-PIECE VALVE STEM

The valve stem, at the right, is for a Smoot turbine-type valve. It was machined from a one-piece, hardened, stainless steel forging. The valve seats and discs are shaped to form a perfect streamlined nozzle at every point in the stroke. The seating surfaces are protected from wear by progressively shifting the zone of maximum velocity.

Smoot pressure-reducing and regulating valves are supplied for all pressures up to 1,500 lbs. per sq. in. and temperatures up to 950 F. They are built for any piping condition. Inlet and outlet sizes are proportioned for specific pressure reductions.

CONTINUOUS INTEGRATION OF FLOW



The Republic integrator is the only type of flow integrator that operates independently of the recorder. It is a separate unit, the accuracy of which is not dependent on or affected by any clock mechanism or other mechanical action. Its operation is continuous, not intermittent, and will, therefore, follow any variation in flow.

Republic remote-reading flow meters are available for measuring the flow of all types of liquids and gases. Meter bodies are built for metering fluids at line pressures ranging from 0 to 10,000 pounds per square inch and for all ranges of differential pressure.

OFFERS A COMPLETE SERVICE

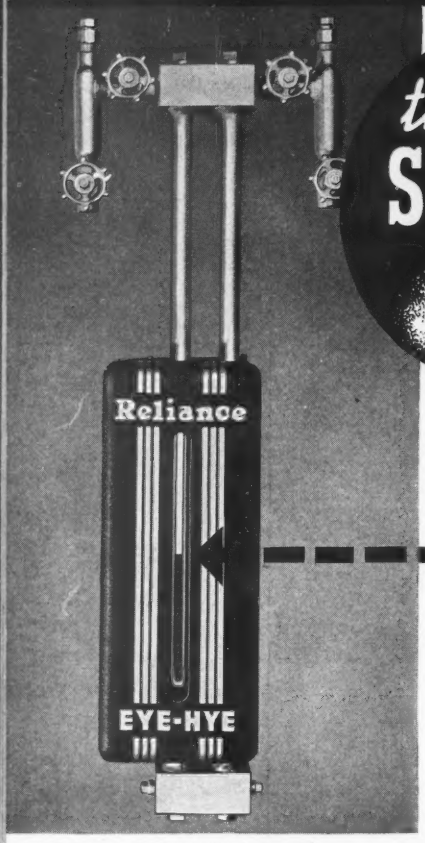
The Republic Flow Meters Co. offers a complete manufacturing and engineering service in the field of measurement and control. Our engineers will be glad to co-operate with you in the solution of any metering or control problem, whether it involves a single instrument or the automatic control of an entire process or plant. Your inquiries will involve no obligation on your part.

SEE THE REPUBLIC EXHIBIT AT THE
National Exposition of Power and Mechanical Engineering
Booth No. 6

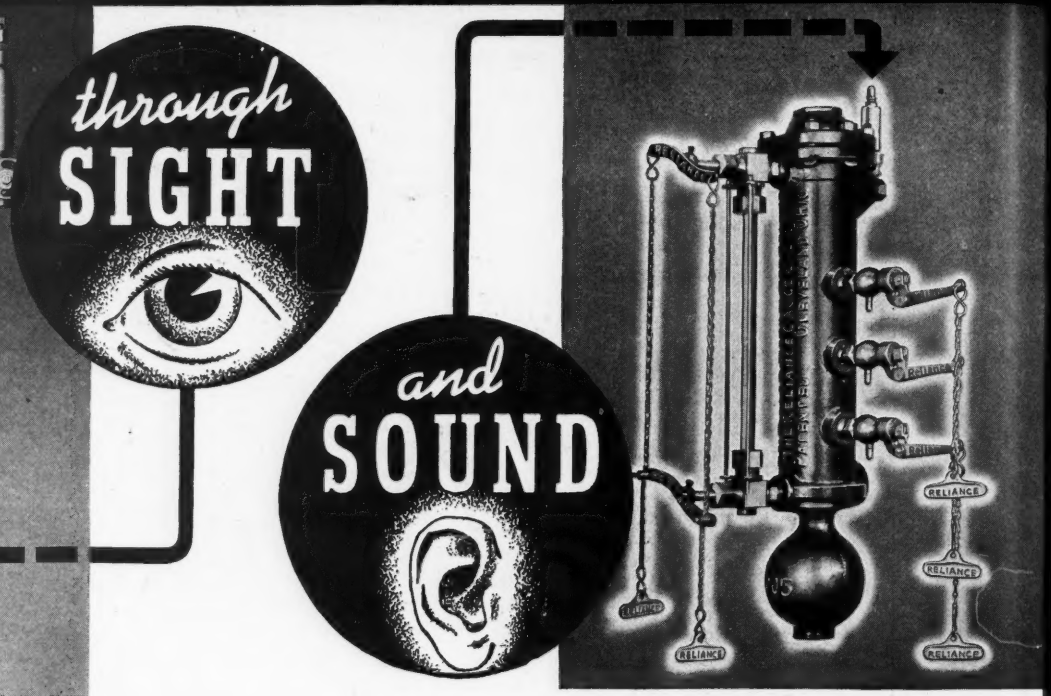
REPUBLIC FLOW METERS CO.

2240 DIVERSEY PARKWAY **CHICAGO, ILLINOIS**

How Reliance Two-Fold Protection Guards Your Boiler Water Levels



Model E-10 EYE-HYE for pressures from 250 to 650 lbs. Other models for pressures to 1500 lbs.



Reliance Boiler Alarm for 250 lbs. and under. Other Alarms for pressures to 850 lbs.

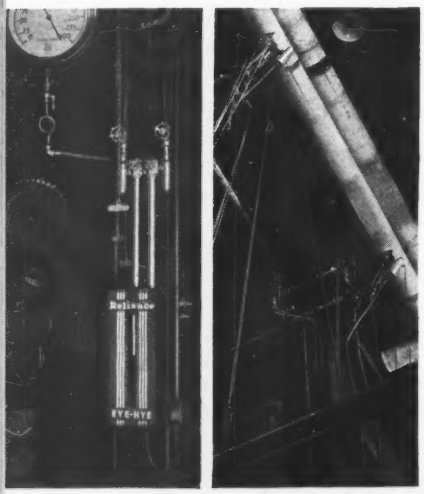
Here's the new sure way to guard against boiler water level accidents: bring your water gages down to eye level with the Reliance EYE-HYE, for convenient *frequent* check — a-n-d — put a never-failing Reliance Boiler Alarm up on the drum to signal sharply when water levels pass the high or low danger point.

1. *The EYE-HYE* — right at your elbow — shows your exact water level in brilliant green, as quick to read as other panel instruments. No guessing, no climbing. Its two copper connecting tubes lead to the drum, around any obstacles — no trouble to install. Sound "U" tube principle assures constant accuracy.

2. *The ALARM* — on the drum itself — stands the gaff of the toughest boiler room conditions but is always sensitive to the slightest water level change, ready to whistle or flash an electric alarm, calling boiler tenders to action.

Make doubly sure, for your personal satisfaction, that your expensive boilers don't suffer from lack of water level control. Be safe, avoid costly damage or interrupted production — write today for full information about Reliance Safety Devices.

THE RELIANCE GAUGE COLUMN COMPANY
5902 Carnegie Ave. • Cleveland, Ohio



Reliance Safety Devices in use in the Gary power plant of the Elgin, Joliet & Eastern R. R.

Down at eye level, Elgin engineers read the EYE-HYE — know exact water level at any moment.

Up there on the boilers the Reliance Alarm stands ready to scream a warning when needed.

Reliance

Boiler Safety Devices for 54 Years

A NEW TWIST IN BRAIDED PACKING...

INTERLOCKED

J-M INTERLOCKED Braided Packing is the most recent development of the J-M Packing Laboratory. Note how the strands of yarn are tightly interlocked to form a solid, square braid that cannot ravel or come apart.

The greatest single improvement ever made in braided packings—J-M Interlocked, developed in the J-M Packing Laboratory, assures longer life, lower maintenance, increased efficiency in high-speed, heavy-duty service.

Above
SQUARE-PLAITED BRAID

Right
BRAID-OVER-BRAID

STUDY the above photograph of Interlocked Braided Packing—notice how it differs from the ordinary types shown at the left. Made by a revolutionary new braiding process, exclusive with Johns-Manville, Interlocked has no layers or jackets to wear through—no plaits to flatten—all the long-fiber asbestos yarns are firmly and permanently interwoven—locked tightly together to form a solid integral structure that cannot ravel or come apart.

Furthermore, because Interlocked is braided square, not pressed into shape, it holds its form in service—presents a better packing face on the rod—provides a tighter seal.

For full details on this new type of braided packing, as well as detailed information on the complete line of J-M Packings and Gaskets, write for the J-M Packing Catalog. Address Johns-Manville, 22 East 40th Street, New York, N. Y.

JM JOHNS-MANVILLE
PACKINGS & GASKETS JUST PHONE YOUR NEAREST DISTRIBUTOR

● *This display in booths 54 and 55 at the New York Power Show will include diagrammatic drawings showing the application of Bailey Meter Control to recent boiler installations, as well as an operating exhibit of Bailey Meter Control.*

COMPLETE COMBUSTION CONTROL

Continuously Maintains Optimum Combustion Conditions

● To continuously receive full value from steam generating units, they should be equipped with complete combustion control incorporating a Steam Flow—Air Flow Boiler Meter to automatically maintain optimum combustion conditions in each boiler furnace.

This system not only maintains steam pressure, furnace draft, and load distribution among boilers, but it also automatically readjusts the fuel or air to maintain maximum combustion economy.

For a maximum return include Bailey Meter Control, the complete combustion control system in your power modernization plan. It is one of the few high-return investments open to you today.

Ask for Bulletin No. 102-B

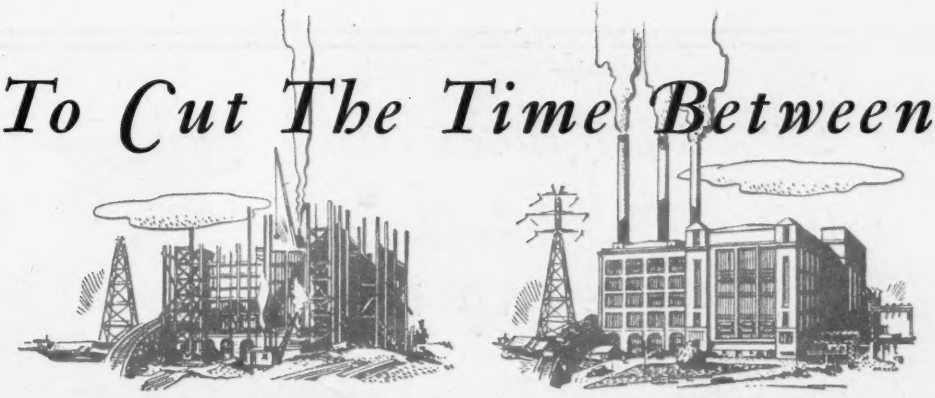
BAILEY METER COMPANY
1040 IVANHOE ROAD • CLEVELAND, OHIO
Bailey Meter Company Limited, Montreal, Canada A-47

BAILEY METER CONTROL

The Complete Combustion Control System

BOILER METERS • MULTI-POINTER GAGES • FLUID METERS • RECORDERS • SUPERHEAT CONTROL • DESUPERHEAT CONTROL • COMBUSTION CONTROL • FEED WATER CONTROL

To Cut The Time Between



INVESTMENT *and* RETURN

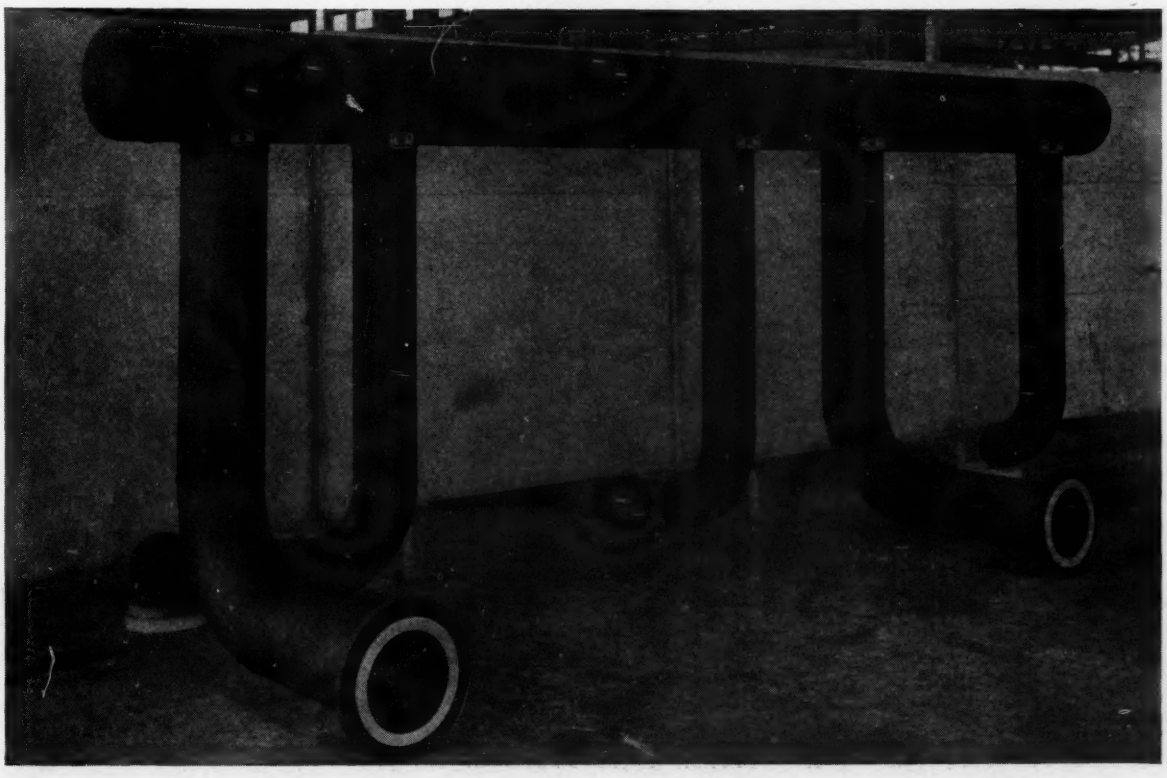
Once the plans are approved, the materials specified and construction begun on your new power plant or process lines, *every day counts.* Your new installation will be more efficient, will return larger profits than the old one — *but not until it is in operation!*

Grinnell Prefabrication provides a sound, tested short-cut to quick erection. Accurate sub-assemblies, prefabricated to specifications, are easily and economically field-welded into a finished piping system, ready for use.

Grinnell's advanced plant facilities, strategically located for service to the East, Central, South and Western parts of the continent . . . Ability to interpret ideas and plans into piping . . . Qualified welders and experienced shop men are among the reasons why it pays to "Give the plans to Grinnell!" Grinnell Co., Inc., Executive Offices, Providence, R. I., Branch offices in principal cities.

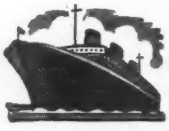
PREFABRICATION BY **GRINNELL**

WHENEVER PIPING IS INVOLVED



"So a ship's engineer can't tell you anything, eh?... LISTEN TO ME!"

Lay aside your work for two minutes and read these true stories. They're not about power plants. But in each one is an experience from which power plants can benefit.



"I'M CHIEF ENGINEER of the sweetest ship on the Great Lakes. For years I'd used a flashlight when I took a thermometer reading in the engine room. Then we installed a new mercury-and-glass thermometer. It was so easy to read I threw away the flashlight and put that make in as standard equipment. Say, I'd recommend it every time, especially where visibility was poor. You want to know its name? Taylor! With that new BINOC Tubing in it."

"FOR YEARS I'VE BEEN PURCHASING AGENT for a color film company. So I was used to having our laboratory requisition 50 mercury-and-glass test thermometers every year. I didn't think they could do with less. But last year we bought a new kind of thermometer. Believe it or not, they got along with only six of them for the whole year. The answer was that this new thermometer required less handling because it was so easy to read. Believe me, that thermometer is economical. Why, it reduced our breakage more than 85%! Taylor Thermometers with the new BINOC Tubing in them more than pay their way."

"ONE OF THE THINGS that made my job as Mill Superintendent tough, was thermometer installations. I never could figure out how to keep them out of our vat operators' way, and still keep them readable. But recently when we needed a new thermometer, I tried another make. Boy, what a difference! We hung it on the far side of the acid vat, and still the operator could read it like a book. If you have a problem like that, just try one of those Taylor Thermometers with BINOC Tubing."

"ME BEING CHAIRMAN of the Employees' Committee, the Boss called me in. 'Joe,' he says, 'you boys are always kicking about the thermometers we use, but after this you won't have anyone to blame but yourselves. Here's a couple of different makes. You try 'em out and tell me which one is the best.' Well, we did. And every man in the place wanted the same thermometer, it was so much easier to read. It was a Taylor, with the new BINOC Tubing."

* * *

Power Plants find in Taylor Industrial Thermometers with BINOC Tubing the same advantages of easier and more accurate reading that you have just read about. This new type tubing more than doubles the angle of vision. It ends squinting, it contains a broader mercury column on which more light is concentrated for quicker reading and longer distances. Let a Taylor Representative give an actual demonstration in your plant. Write for information to Taylor Instrument Companies, Rochester, N. Y. Plant also in Toronto, Canada. Manufacturers in Great Britain, Short & Mason Ltd., London, England.

Taylor

Indicating Recording Controlling

TEMPERATURE, PRESSURE, FLOW *and* **LEVEL INSTRUMENTS**

when you install a gauge glass specify

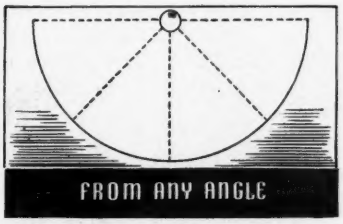
THE NEW BROAD RED LINE GAUGE GLASS

SAFETY is not to be overlooked when you install new gauge glasses. That is why it will pay you to weigh carefully the exclusive advantages of the *new* "PYREX" Broad Red Line Gauge Glass.

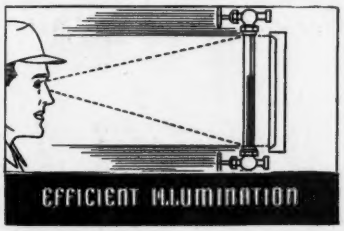
Not only is it safer because of the greater strength of "PYREX" Brand Glass, but also because of its unique construction. A broad, transparent red line fused into the wall of the gauge glass itself increases visibility and makes it possible to accurately determine fluid level from any angle and at greater distances. *If you can see the gauge glass you can read the fluid level.*

"PYREX" Broad Red Line Gauge Glasses like all "PYREX" Gauge Glasses also possess: machine drawn accuracy that avoids installation strains and breakage; remarkable resistance to heat and cold; clearness that assures maximum visibility; and chemical stability that eliminates clouding and pitting and insures a longer period of visibility.

Stocked by leading steam and mill supply dealers.



It is easier to read. **The broad red line makes visibility of the fluid level greater from every angle.**



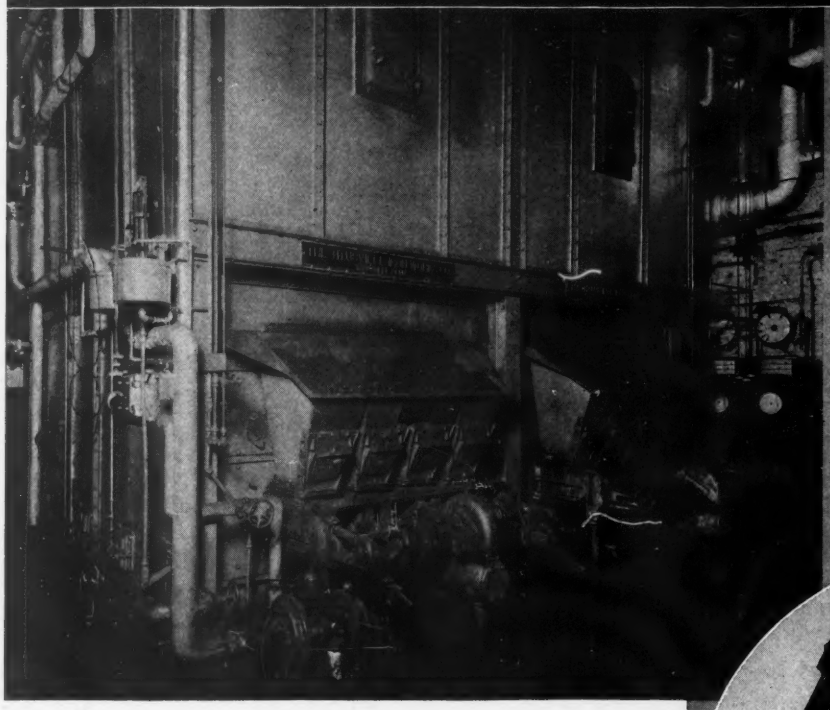
Visibility is further increased **by illuminating the *transparent* red line from the rear.**

Pyrex BRAND GAUGE GLASSES

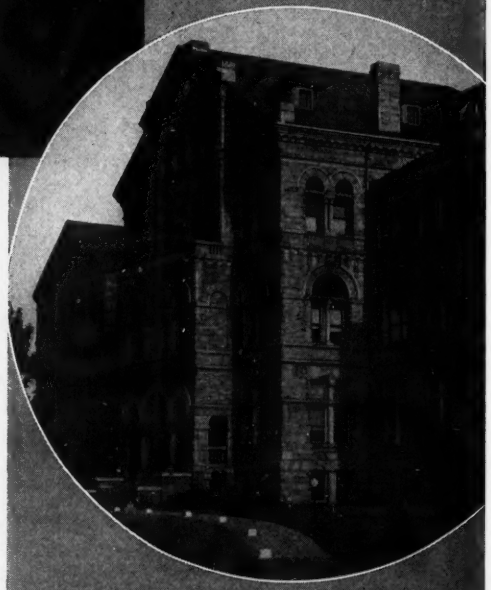
CORNING GLASS WORKS, CORNING, N.Y.

"PYREX" is a registered trade-mark and indicates manufacture by Corning Glass Works.

Estimated Savings of $2500



DETROIT MULTIPLE RETORT STOKERS AT THE CATHOLIC UNIVERSITY OF AMERICA — WASHINGTON, D. C.



Detroit Multiple Retort Stokers
The Catholic University of America, Washington, D. C.

● Based on degree days, last heating season, Mr. R. E. Robson, Mechanical Superintendent of The Catholic University of America, Washington, D. C., estimates savings of approximately $2500 by use of Detroit Multiple Retort Stokers with new boilers. ● Mr. Robson has also expressed himself as highly pleased with the overall efficiency and the general operation of the Detroit Stokers. ● Design of Detroit Stokers embodies every feature which can promote economy both in fuel used and in maintenance. ● Deep, square, high capacity retorts, *inclined tuyeres . . . square rams* . . . adjustable moving retort bottoms that provide even fuel distribution . . . correct air distribution by zones . . . rugged, heavy construction—easy adjustment—these features make Detroit Multiple Retort Stokers exceptional in economy and satisfaction. ● Write for Bulletin 124.

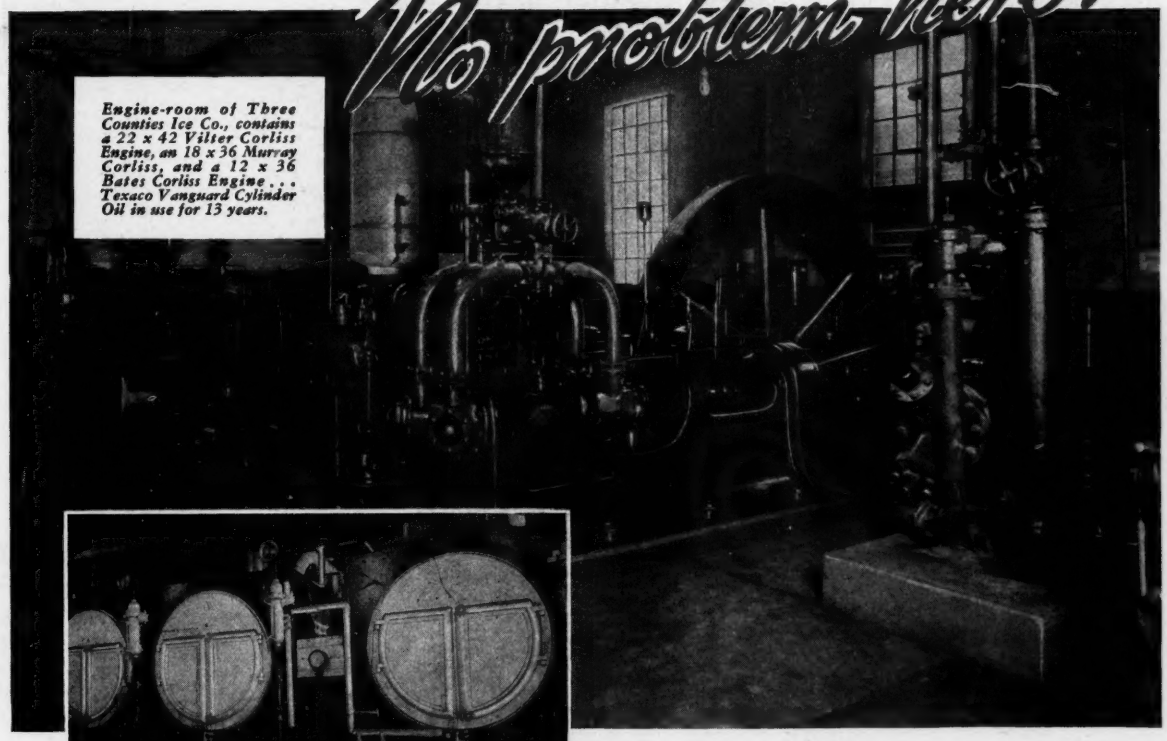
DETROIT STOKER COMPANY

Fifth Floor, General Motors Building ● Detroit, Michigan
Works at Monroe, Michigan . . . District Offices in Principal Cities
Built in Canada at London, Ontario

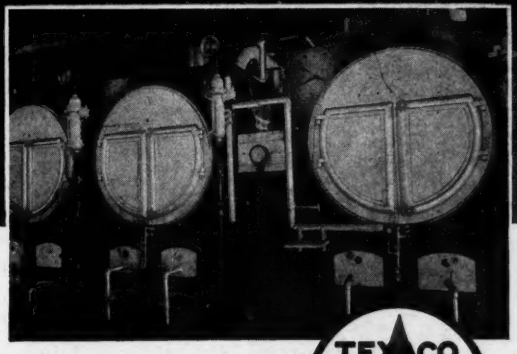
DETROIT STOKERS

SEPARATION

No problem here!



Engine-room of Three Counties Ice Co., contains a 22 x 42 Vilter Corliss Engine, an 18 x 36 Murray Corliss, and a 12 x 36 Bates Corliss Engine . . . Texaco Vanguard Cylinder Oil in use for 13 years.



Boiler-room of Three Counties Ice Co. Boiler efficiency is maintained because Texaco Vanguard Oil separates out of the feed water.

THIS DISTILLED WATER ICE PLANT in Wichita Falls, Texas, must have rapid and complete separation of oil from condensate.

For 13 years Chief Engineer Collins has been getting it. For 13 years he has been lubricating his 3 Corliss Engines with Texaco Vanguard Cylinder Oil.

To get this quick separation in *your* plant, use Texaco.

There are 14 different Texaco Steam Cylinder Oils, and trained lubrication engineers will be glad to help you select and apply the right ones.

2186 Texaco warehouses assure prompt deliveries. Order from the nearest, or write direct. The Texas Company, 135 East 42nd Street, New York City.

TEXACO

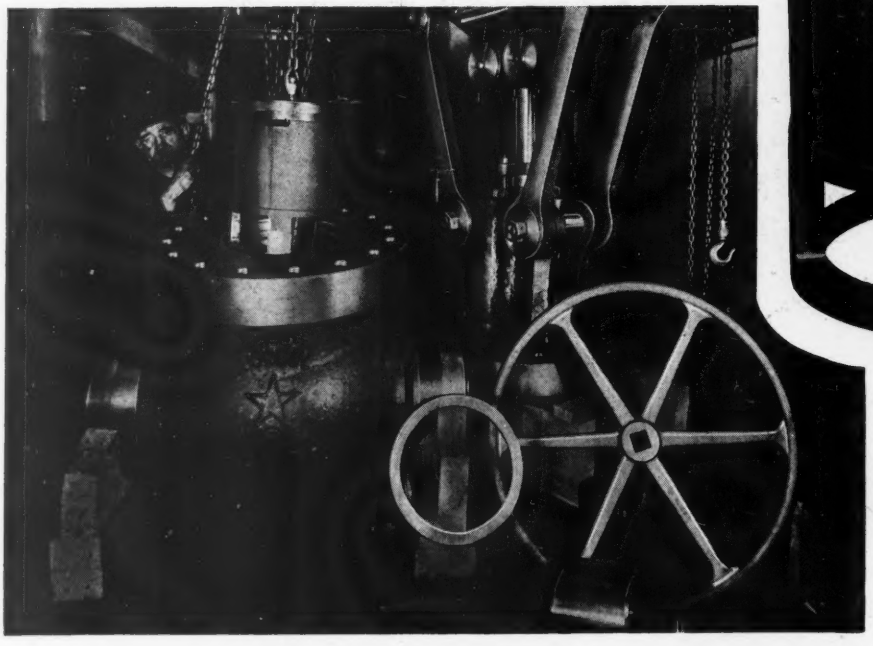
Steam Cylinder

OILS

Texaco Dealers invite you to tune in The Texaco Star Theatre —a full hour of all-star entertainment—Every Wednesday Night—Columbia Network—9:00 E.S.T., 8:00 C.S.T., 7:00 M.S.T., 6:00 P.S.T.

Non-Galling and Long Wearing

At 1500 lbs. pressure... 900°F. Temperature



(Left) 12" toggle-operated non-return valve with welding ends for 1500 lbs. w.s.p. at 900° F. Mfd. by The WM. POWELL COMPANY, Cincinnati, O. Cylindrical guide for disc, and disc itself shown in foreground, are made of cast "S" Monel, heat treated to 320-350 Brinell. Insert above shows close-up of cylindrical guide.

"S" Monel proves ideal material for cylindrical guide liners, discs and seat rings

The working parts in the massive valve and toggle mechanism above must take the brunt of a working steam pressure of 1500 lbs., temperature of 900° F. The valve disc and its cylindrical guide parts are made of "S" Monel!

Experience has taught The Wm. Powell Company of Cincinnati, makers of these valves, that for cylindrical guide liners, discs and seat rings used in high-temperature service, "S" Monel is an ideal material. Its red heat hardness is over 300 Brinell at 1000° F. Also immune to rust and highly resistant to corrosion, non-galling "S" Monel withstands the corrosive and erosive action of live steam.

But that is not all. Tests made by The Wm. Powell Company's own metallurgists, on 23 different valve materials, prove that "S" Monel rates tops from the standpoint of economical dependability.

Where high-pressure, high-temperature operation causes undue corrosion, erosion and wear, specify "S" Monel. Use this enduring *high-temperature* alloy for freedom from trouble and long service life. Write for further information on "S" Monel. Address:

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street New York, N. Y.

Monel INCO MONEL

"Monel" is a registered trade-mark of The International Nickel Company, Inc., which is applied to a nickel alloy containing approximately two-thirds nickel and one-third copper.

Shell saved Capt. Tom Brigham oil bills equal to 400 pounds of cod

CAPT. TOM BRIGHAM of the "Eleanor" from Central Wharf, Portland, Maine, had no kick about his lubricating oil—except the fancy price he was paying for it. His heavy-duty, 80-H.P. Diesel hummed along like clockwork—always brought the catch in on time.

But that oil was costing him plenty of money—and the Shell man knew it!

"Capt. Brigham," said the Shell representative, "I know your Diesel, and I know the oil you're using in her. I know what Shell Diesel Lubricants can do. I can give you a perfect lubricating job—at a lot less than it's costing you now."

Capt. Brigham decided to give the Shell Lubricant a chance. The crankcase of the "Eleanor's" Diesel was drained and flushed, then filled with Shell Marine Argus Oil 46.

Again, day after day, the "Eleanor's" Diesel hummed along off the Nova Scotia banks. It wasn't till Capt. Brigham examined his books that he really saw what Shell had done for him.

"Savings!" he said. "You're saving me the price of 400 lbs. of cod—every month. In other words—I'm starting from the pier with a *bonus!*"

No matter what the problem—sticking rings or rising oil costs—Shell finds the answer! "Case histories" like this one from every port prove it. Shell applies to *your* problem a *plus* in lubrication: The finest lubricants on the market—the "know how" to apply them correctly. The next time trouble threatens, call or write your nearest Shell office.

SHELL DIESEL SHELL LUBRICANTS

75 YARWAY IMPULSE TRAPS Serve PEPPERELL

Illustration shows six of nine Yarway Impulse Traps installed on Proctor and Schwartz Dryer at Pepperell's Lindale, Georgia, Plant.

Draining

- DRY CANS
- RAW STOCK DRYERS
- SANFORIZERS
- STEAM HEADERS
- LAUNDRY EQUIPMENT

Pepperell puts the nation to sleep — between snowy white sheets. And Yarway Impulse Steam Traps are proud to have a hand in it — by providing more efficient operation of all sorts of steam-heated processing and laundering equipment in Pepperell's great Lindale, Georgia, Plant.

"Our use of this large number of Yarway Traps," states Mr. Comer Turley, mechanical superintendent of this plant, "is conclusive proof that we are well satisfied with them."

Yarway performance talks. Their quicker heating and greater sustained heating efficiency soon pay for their installation and continue on to return worth-while profits in plant operating economy. And when you consider that their purchase price is usually no more than the cost of repairing an ordinary trap — why not *get* Yarway performance for *your* money?

Install a Yarway Impulse Trap or two and let them demonstrate what they can do for you in speeding production and saving fuel. See how its small size saves space. How its light weight simplifies installation. How its unique design with only one moving part, and its rugged bar-stock construction, practically eliminate maintenance expense. Then too, Yarway Traps are suitable for all pressures without change of valve or seat.

A nearby Mill Supply Dealer handles Yarway Traps and will be glad to serve you. Or write for Catalog T-1733.

YARNALL-WARING COMPANY
114 Mermaid Ave., Philadelphia

SEE OUR EXHIBIT—
Booth No. 66, Power Show, Grand Central Palace, New York City, Dec. 5 to 10, 1938

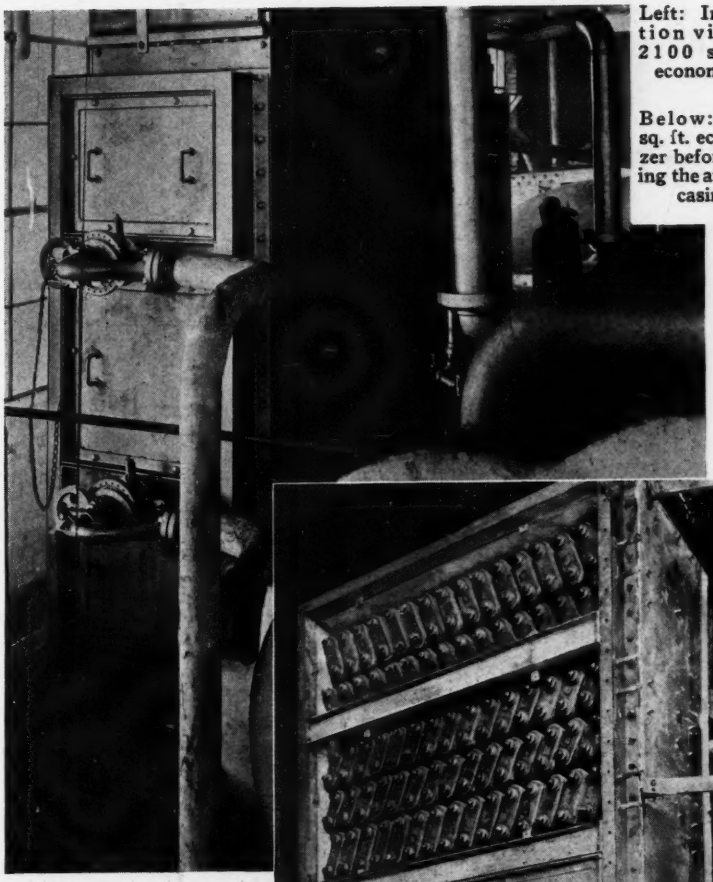
YARWAY IMPULSE STEAM TRAP

Cast Iron armored, extended surface ECONOMIZERS

High heat recovery

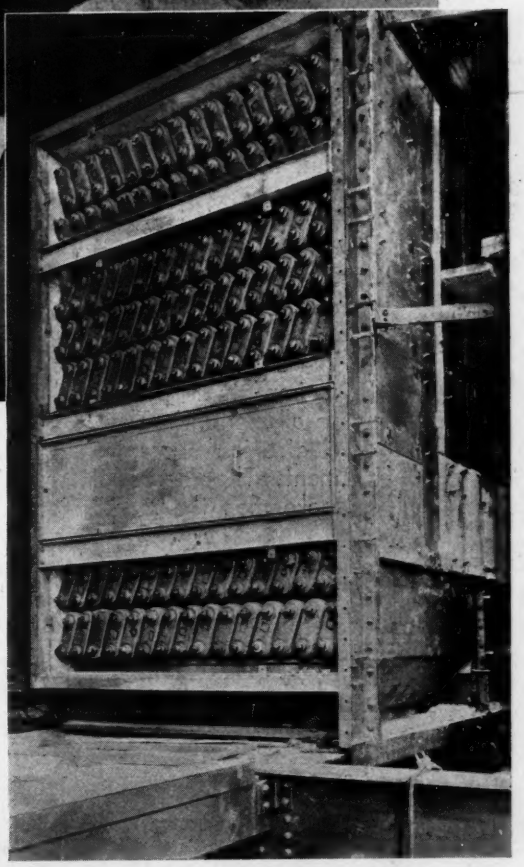
Low maintenance

Increased overload capacity



Left: Installation view of 2100 sq. ft. economizer.

Below: 14,580 sq. ft. economizer before sealing the air-tight casing.



The most effective means of heat recovery from flue gases to feed water is by *extended surface:*

Greatest area in least space.

Direct access for inspection or cleaning.

The strength of steel with the durability of cast iron.

FOSTER WHEELER CORPORATION
165 BROADWAY, NEW YORK, N. Y.

FOSTER WHEELER

Making Man the Master of Machines

A recent General Electric advertisement tells us that in 1896 the average factory worker had only one horsepower of mechanical aid. He did almost everything by hand. Today each factory worker has 12 horsepower of mechanical power to help him produce.

Our present mechanized power age is not making work unnecessary. It is furnishing relief from backbreaking toil, helping men earn a living in shorter hours. It is contributing greater conveniences for the industrial, business and home life of the American people.

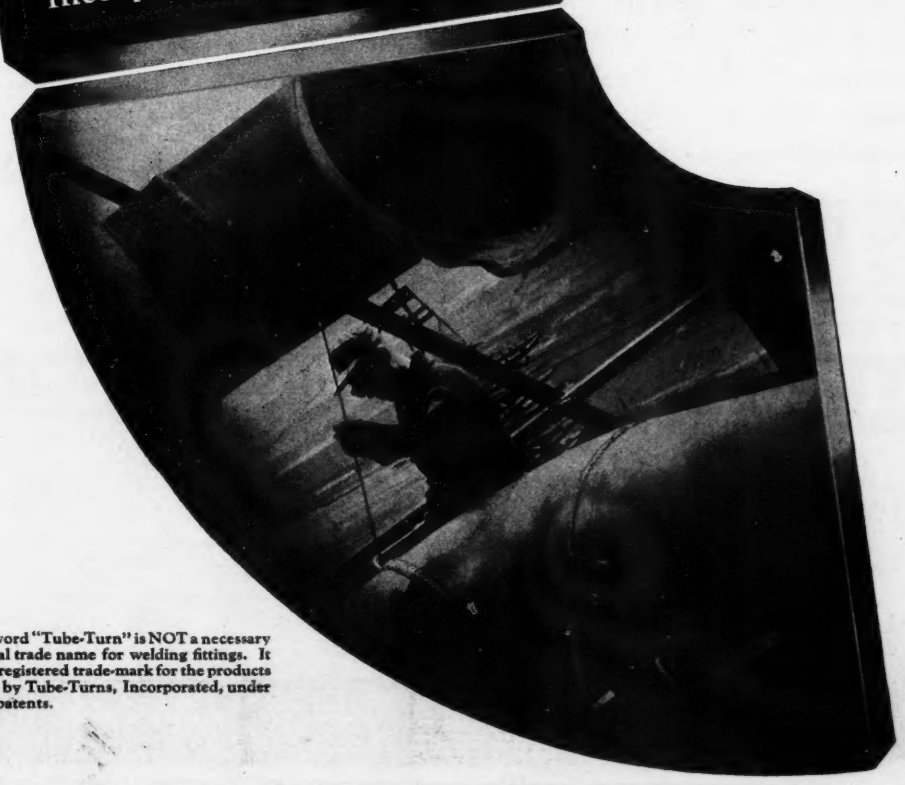
Armed with modern power-generating and power-utilizing machinery, thousands of men now rise to a higher order of workmanship in each industry than that reached by even a few men using hand-operated tools in earlier days.

The advertisements appearing in POWER PLANT ENGINEERING play an important part in applying the ingenuity of the inventor and engineer to all mankind. They describe latest boilers, turbines, engines, motors, electronic devices, transformers and other marvelous machines and equipment. They spread information and facilitate distribution. They help make men the masters of machines.

Should you desire catalogs on latest power units or need help on specific plant operation problems, let us know about it. Write to Reader Service Department, POWER PLANT ENGINEERING.

Higher standards, LOWER COSTS with TUBE-TURNS and Welding!

Any welder knows that he can do a far better job, in far less time, when his fittings "line up" with the pipe. This isn't a mere *theoretical* advantage of Tube-Turns—it's a fact that you can prove with stop-watch and testing coupon. . . If you'll inspect any Tube-Turn that has been cut away to show its uniform wall-thickness and its true round cross-section, we believe you, too, will join the *majority* of piping experts who "insist on Tube-Turns". . . Tube-Turns, Incorporated, Louisville, Ky.



The word "Tube-Turn" is NOT a necessary general trade name for welding fittings. It is the registered trade-mark for the products made by Tube-Turns, Incorporated, under their patents.

KENNEDY

VALVES~PIPE FITTINGS~FIRE HYDRANTS

Wherever iron body globe valves are to be used, this Kennedy type and similar designs for higher pressures will assure satisfactory service with tight closure and minimum pressure drop. These valves have many special features that help to provide convenience and economy of operation. For example, the standard valves can be supplied with renewable composition disc or regrinding bronze faced disc. The discs of the extra heavy valves have a lip or leader which makes the seat self-cleaning and minimizes wire drawing. Accurate seating and elimination of disc rattling are assured by a disc guide pin and guide in the seat ring. Lugs on the yoke on which to rest the gland, assist in repacking, which can be done under pressure.

The Kennedy catalogue fully describes these valves and the many other types of Kennedy Valves and Fittings. Send for your copy today.

The Kennedy Valve Mfg. Co., Elmira, N. Y.

Branches in principal cities

For **UNCOMMON QUALITY** in Valves, Fittings, Pipe and Piping Accessories, specify Crane-Equipment. Backed by 80 years of manufacturing experience.

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VALVES • FITTINGS • PIPE • PLUMBING • HEATING • PUMPS
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NATION-WIDE SERVICE THROUGH 134 BRANCHES AND MORE THAN 500 WHOLESALERS

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What It Is——————and How It Acts

The two volumes in this set on ELECTRICITY have been written by an engineer who is an authority on electrical matters. They are designed especially for power plant men who find an increasing need for clear conceptions of the fundamentals of electricity. One enthusiastic reader has written, "I find these books more intensely absorbing than any fiction thriller I have ever encountered." They tell in simple language and with clear graphic illustrations all that is known about electricity today. A folder showing the chapter titles will be sent on request.

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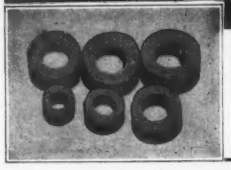

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"SPLIT-GLAND" Water Gages Will Fit Any Type of Water Column or Boiler

for All Pressures—Easy to Install a Gage Glass

STOP YOUR GAGE GLASS BREAKAGE!

SERIES 750—HIGH PRESSURE ERNST COMPOSITION GASKETS Made to Fit Your Packing Nuts Perfectly. Send for Washer Chart.

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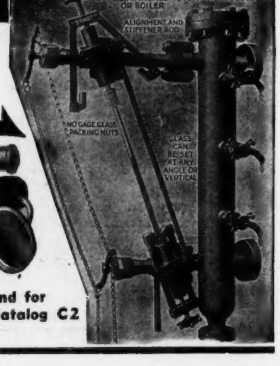

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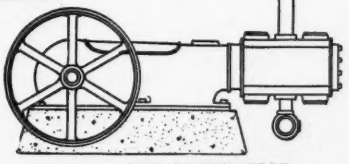
How to keep your Air Lines DRY

THE GENUINE *Squires* AIR TRAP

Scores of plants rely on the Genuine Squires, Air Trap to prevent water being carried over into the compressed air lines and ruining pneumatic tools. The drawing shows the simple, effective arrangement used. The Squires Trap discharges the water as fast as it collects. Want full details?

Write today for Catalog E-9½



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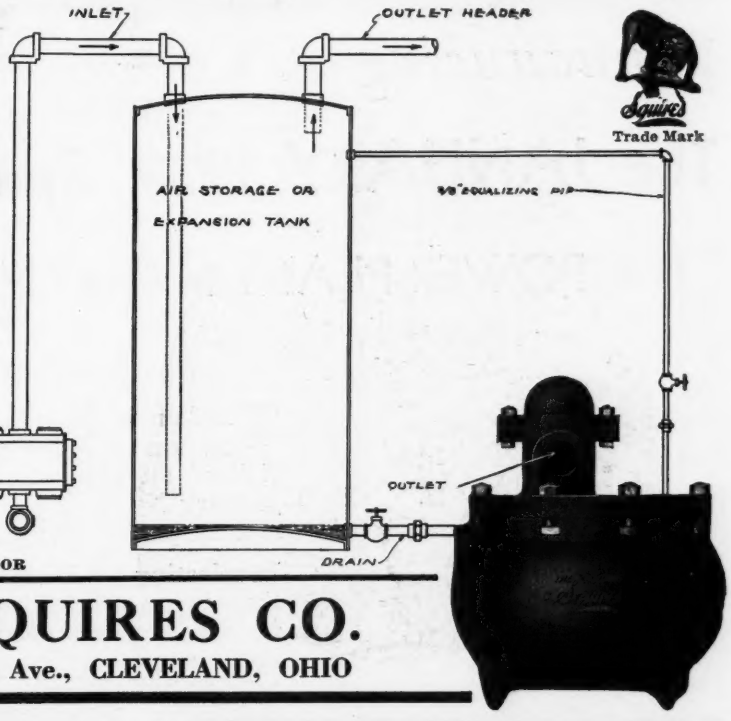

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The C. E. SQUIRES CO.

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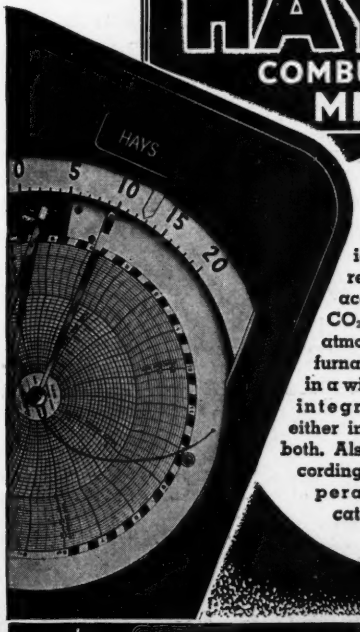

OPERATE on the Orsat principle of volumetric measurement and chemical absorption—the most reliable method known for accurately determining the CO_2 content of flue gases, of atmospheres in heat treating furnaces, kilns, etc. Supplied in a wide variety of remote and integrally mounted models, either indicating or recording or both. Also for indicating and recording draft and flue gas temperature. Write for new catalog—just off the press.

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SINCE 1907 — COMBUSTION INSTRUMENTS AND CONTROL — MICHIGAN CITY, INDIANA, U.S.A.

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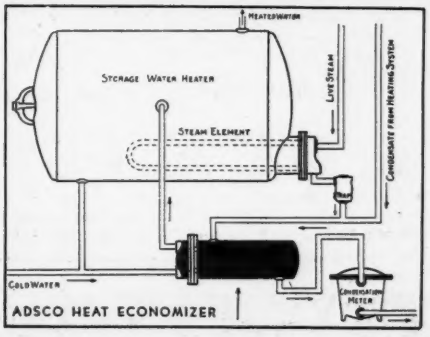
FOR RECLAIMING HEAT FROM HOT CONDENSATE



ADSCO HEAT ECONOMIZER

PUT YOUR HOT CONDENSATE TO WORK

Get full heat value from hot condensate by the installation of an ADSCO Heat Economizer to preheat cold water for domestic hot water supply, washing, cleaning or processing purposes. Typical installation above is only one of many applications. Made in all sizes of Instantaneous and Storage Types. Write for illustrated Bulletin No. 35-76E or submit requirements for recommendations and quotation.

AMERICAN DISTRICT STEAM COMPANY

NORTH TONAWANDA, N.Y.

IN BUSINESS OVER SIXTY YEARS

Announcing . . .

The JANUARY 1939 Specialized Number

"THE POWER PLANT In Our CHANGING WORLD"

THE power plant field has come to expect each January an issue of POWER PLANT ENGINEERING specialized on some subject of timely importance. These January Numbers are now traditional and form a permanent part of many engineers' libraries.

In selecting a subject for January 1939 one great need of the power plant field stood out above all others; the need for focusing the attention of the nation on the tremendous importance of the power plant in man's past, present and future progress.

Among the absorbing topics to be discussed in January POWER PLANT ENGINEERING are: Power Resources of the World, The Rise in the Use of Power, Place of the Power Plant in Industry and Society, Power and Labor, Growth of Utilities in the United States, Research and New Power Uses, Power as a National Problem, What Lies Ahead?

In the January Number the stage is set for the power plant advertiser to portray his role in our changing world. The advertising pages provide a rare opportunity to tell in word and picture of his own contribution to the growth of the power plant field. Copy due December 10; printing begins December 17. Send space reservation promptly.

Like previous Specialized Numbers, the price of January POWER PLANT ENGINEERING will be 50c a copy. To insure delivery, extra copies must be ordered in advance.

TECHNICAL PUBLISHING COMPANY
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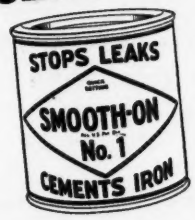
Now Ready — and SENT FREE!

NEW ENLARGED EDITION — 25% more information and diagrams
A veritable encyclopedia of good repair and construction practice

SMOOTH-ON CEMENTS



for the
Motor Car and Boat, Home, Factory and Power Plant

THIS Handbook enables any Engineer to make countless routine and emergency repairs quickly, easily, at low cost and with assured results. By following its instructions and diagrams, you can prevent or stop fluid and pressure loss at cracks and joints in boilers, steam, air or pump cylinders, valve decks, pipe lines, condensers, feed heaters, stills, tanks, etc., seal porous spots in cast metal, tighten stripped bolts, nuts or screws, anchor parts to wood, metal or masonry, make rigid machine base contacts and oil-proof foundations, seal cracks against the corrosive action of moisture, prevent the entrance of ground water through floors, walls, sumps, machinery pits, etc., harden or patch concrete floors—all with least effort, time loss and expense.

For over 40 years the Smooth-On Iron Cements have been used in power plant repair and construction work. Constant improvement in the composition of the different Smooth-On Cements is being made by laboratory experimentation. For instance, the hardness, strength and working time of Smooth-On Iron Cement No. 1 have recently been doubled. Easy to apply, without tools or heat. Just mix with water.

The new Handbook is up-to-date with new uses found by test and from experiences of the many Smooth-On users. Its information is valuable, and should be on every Engineer's desk.

Mail this coupon for your copy

and get Smooth-On in 1-lb. or 5-lb. can or larger package from your supply house.

SMOOTH-ON MFG. CO., Dept. 31,
570 Communipaw Ave., Jersey City, N. J.

Please send SMOOTH-ON HANDBOOK, 1939 Edition.

Name .....

Address .....

12-38 .....

Do it with **SMOOTH-ON**

BROWN FLOW METERS

Pyrometers
CO_2 Meters
Tachometers
Hygrometers
Thermometers
Pressure and Vacuum Gauges
Motorized Valves
Liquid Level Gauges

Electric or Air Operated

Indicating, Recording, Controlling, Signalling

Write for Catalogues. The Brown Instrument Co., a division of Minneapolis-Honeywell Reg. Co., 4491 Wayne Ave., Philadelphia, Pa. Offices in all principal cities. Toronto, Canada: 117 Peter St. . . . Amsterdam-C, Holland: Wijdesteeg 4. . . . London, England: 70 St. Thomas St., S. E. 1.

To Measure and Control is to Economize

HENSZEY

CONTINUOUS BLOWDOWN

This system offers complete automatic control of Boiler water impurities — eliminating the common boiler troubles of priming, foaming and the formation of scale. The outstanding feature of this system is the fact that this can be accomulished without heat loss!

HENSZEY CO. Dept. C12 Watertown, Wis.

Effective for Every STEAM-REDUCING PURPOSE

Whatever steam-reduction you require, there is a C-F Regulator of the Lever and Weight type to accomplish it. The regulator here shown is for low-pressure heating systems where initial pressures as high as 200 pounds must be reduced to delivery pressures of 5 or 10 pounds. Sizes of 1 to 2 inches can be provided with outlets of greater diameter.

Chaplin-Fulton Regulators have been used and approved for fifty years. Advice as to type and specification for any particular requirement will be gladly given.

The
CHAPLIN-FULTON MFG. Co.
28-40 Penn Ave. Pittsburgh, Pa.

Give The Little Can A Big Hand!

"The Entirely Different Boiler and Engine Treatment

That's what power plant operators in all industries are doing. Such popularity must be deserved!

Sand-Banum is always "on its toes". It comes ready for use in 16 ounce cans and one can will protect a 250 Hp. boiler from scale and corrosion for one month!

Sand-Banum is a "great performer". It does a perfect job regardless of the operating conditions or the nature of the water used!

"Swing" in with this popular trend that is increasing efficiency and economy wherever it is used. Its pure colloidal action is absolutely harmless. Yet, every can is sold on a "Satisfaction or No Money" guarantee!

Send for booklet "HOW and WHY" Then try Sand-Banum on our "Satisfaction or No Money" guarantee!

AMERICAN SAND-BANUM COMPANY, Inc.

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BAYER
SOOT CLEANERS

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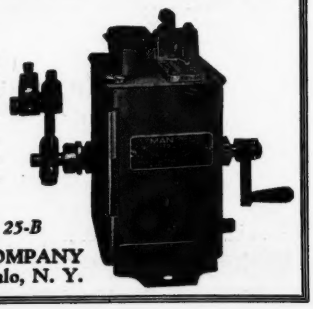
CATALOGUE SENT ON REQUEST

THE BAYER CO. 4065 PARK AVE. ST. LOUIS

MANZEL FORCE FEED LUBRICATORS
Model "25"

The correct application of oil, as provided by "Manzel" Model "25" Lubricators, keeps machinery fit for steady service.

Users everywhere report better lubrication with less attention and 30% to 60% reductions in oil bills.



Write for Catalog No. 25-B

MANZEL BROTHERS COMPANY
327 Babcock St. Buffalo, N. Y.

If You Have a Problem

Let the editors of POWER PLANT ENGINEERING help smooth out your problems on the construction, use or maintenance of power equipment. Write Reader Service Department, giving necessary details of operation.

THE PURE OIL CO.

PURE THREE POINT LUBRICATION

PURE THREE

A COMPLETE LINE OF INDUSTRIAL PETROLEUM PRODUCTS

CHICAGO U.S.A.

Twelve years ago . . .

WE GUARANTEED SAVINGS IN POWER COSTS FOR THIS INDUSTRIAL PLANT . . . . . .

Here's what its President says today . .

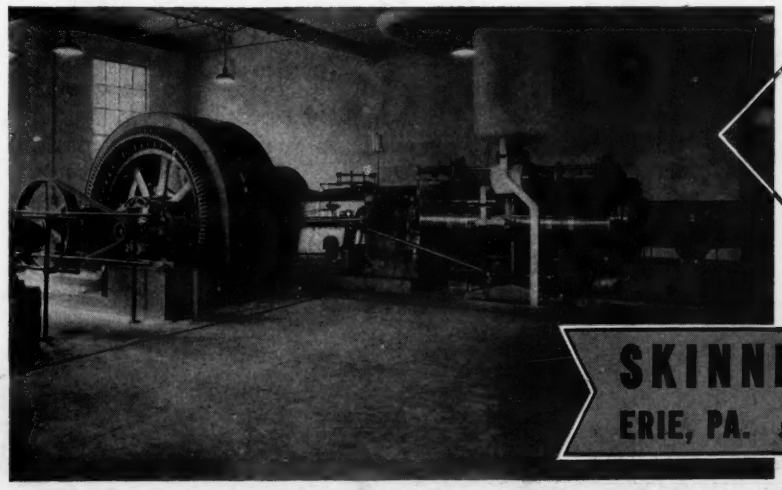
HERE'S A CONTRACT THAT *Guarantees* THE SAVINGS

. . . "to set up any figures which would show the Skinner Engine to a disadvantage as against purchased power would be impossible."

This company had been buying power. Our survey showed that a Skinner "Universal Unaflow" Steam Engine would generate power for them at a yearly saving of $17,000.00. We guaranteed this saving *with our own money* by furnishing the engine for an initial payment of $1,000.00 The remainder of the contract price to be paid to us only out of savings.

The first year, this power generating unit saved approximately half its total installed cost. As a result, for the last ten years, the income of this industrial plant has been increased by the earnings on an investment which was retired out of savings in about two and one-half years.

Hundreds of similar cases have resulted in savings of millions of dollars from the installation of power generating equipment furnished under the Skinner Guaranteed Saving Contract. A booklet, "List of Users," and cases in your industry will be mailed at your request.



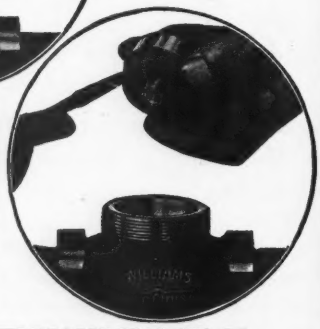
HERE'S THE ENGINE THAT MADE THESE SAVINGS POSSIBLE

SKINNER ENGINE CO.
ERIE, PA. *Sales Offices in Principal Cities*

Use VULCODISC

for trouble-free valve jobs

In renewing the disc, note how easily and quickly the Vulcodisc Jiffy Disc Holder slips off the stem head. Only the disc lock nut to remove and the old disc is off and replaced in a jiffy.



Dense without being brittle—tough, yet resilient, Vulcodisc will not swell, warp or soften—in fact its absorption is less than 1 per cent. . . That is why an old Vulcodisc comes out of the disc holder as easily as a new one goes in. No need for hammer and chisel to cut the disc out in pieces—distorting and disfiguring the holder.
Write for descriptive bulletin.

THE D. T. WILLIAMS VALVE CO.
Cincinnati, Ohio

4600 Chimneys

have been built by this organization. No charge for preliminary sketch, estimate and specifications. Our service also includes Boiler Settings, Linings for Steel Stacks, Repairs and Extensions of chimneys. Write us today for complete catalog.

American Chimney Corporation
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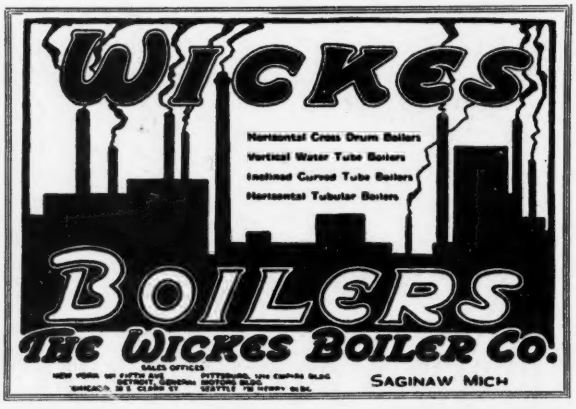
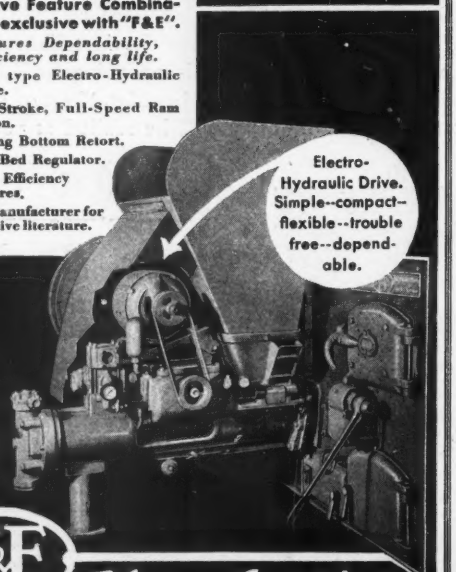


Hydraulic Powered
UNDERFEED STOKER

This Five Feature Combination is exclusive with "F&E".
Assures Dependability, efficiency and long life.
1. Unit type Electro-Hydraulic Drive.
2. Full-Stroke, Full-Speed Ram Action.
3. Sliding Bottom Retort.
4. Fuel Bed Regulator.
5. High Efficiency Tuyeres.

Write manufacturer for descriptive literature.



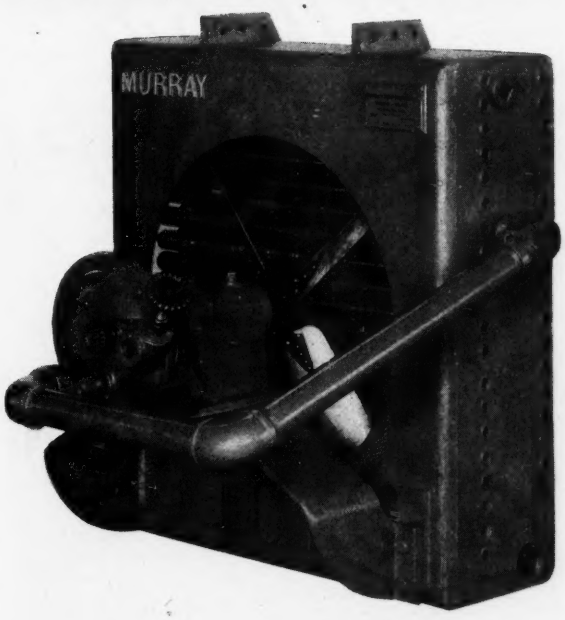
F&E Flynn & Emrich Co.
ESTABLISHED 1842 BALTIMORE, MD.

If You Have a Problem . . .

or if you need information on the construction, use or maintenance of any kind of power equipment, the editorial staff of POWER PLANT ENGINEERING will be glad to help you find a solution or get the desired information. Please give as complete details as possible as to what you want so that the editors may have a clear understanding of your wishes.

Write Reader Service Department, POWER PLANT ENGINEERING.

TURBINE-DRIVEN UNIT HEATERS



Murray Turbine-Driven Unit Heaters offer unique advantages:

1. Saving of electrical power as the steam drives the turbine and exhausts from the turbine into the heater where it is condensed. Added steam consumption is negligible, as it never exceeds one-half percent.
2. No wiring, starters, fuses, etc.
3. Elimination of fire hazards due to wiring, sparks, etc.
4. Failure of current will not interrupt heat.
5. In many cases, insurance costs reduced.

Complete Information in Bulletin T-115

MURRAY IRON WORKS COMPANY, BURLINGTON, IOWA.

"IT'S EASY... and SAFE, too!"

with this Snap-on JUMBO Ratchet . . .

Here's small-tool efficiency for your biggest jobs . . . nut-to-nut speed that makes short work of big tie-ups.

One man can handle this Snap-on Jumbo ratchet easily . . . use it *safely* . . . save the time of several men. For there's no "taking off" and "putting on" . . . the socket clings to the nut until you're through . . . the ratchet works as smoothly and surely as a well-oiled piston. And it squeezes into places no ordinary wrench can go . . . clears most obstructions with room to spare.

It's a pleasure to work with a ratchet like this . . . and a safeguard, too, for important machinery, and for even more important maintenance costs.

Include this Snap-on JUMBO in your equipment . . . "keep going" dependably and economically.

Check your phone directory for the nearest Snap-on service office . . . or mail coupon for FREE 160-page catalog.

Snap-on Tools Corporation
Kenosha, Wisconsin

Snap-on Socket Wrenches
Blue-Point Mechanic Tools

SNAP-ON TOOLS CORPORATION
Kenosha, Wis.

☐ Without obligation send representative to show me the JUMBO ratchet.

☐ Send free catalog.

Name .....

Address PPE-12

TUBE CLEANERS

trouble savers on all kinds of tubes -- small or large straight or bent

WITH Wilson Tube Cleaners, time, labor and effort are saved in descaling straight or bent tubes in boilers, condensers, heat exchangers, etc.

These modern powerful cleaners work fast and do a thorough job in shortest time. Periods between cleaning are definitely extended.

By assuring cleaner tubes over longer periods of time, users of Wilson Tube Cleaners are directly benefited by the fuel savings which come from higher efficiency in heat transfer.

Long life under severe service conditions is assured by the many unique features of design incorporated in the construction of these sturdy units.

Many leading power plants are saving money by using Wilson Tube Cleaners. You have the same opportunity.

Wilson Tube Cleaners are available for straight or curved tubes as small as ½" I.D. A wide range of rotary brushes and cutter heads to meet all requirements is also available. Write for specific information and assistance on your tube cleaning job.

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Inc.

55 VANDAM ST. NEW YORK, N. Y.

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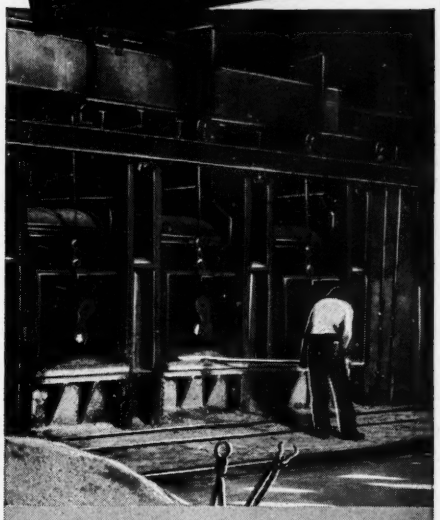
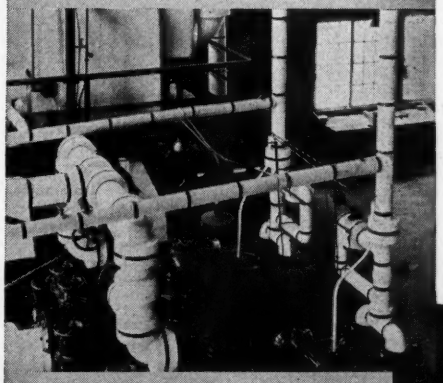
ARE YOU GETTING YOUR SHARE OF THIS $250,000,000 A YEAR?

Over a quarter of a billion dollars . . . that is the staggering amount J-M Insulations save American Industry *every year* by reducing fuel and refrigeration costs. And here is how you can be sure your plant receives its full share of this huge saving . . .



$11,000 ANNUAL SAVING—In 1927, the regenerators and flues of this open-hearth furnace in a large Ohio steel foundry were insulated with Johns-Manville materials, applied in accordance with the recommendations of a J-M Insulation Engineer. The net fuel savings *every year* have been more than 400% of the cost of insulation.



SAVING FUEL, INCREASING EFFICIENCY—This power plant is typical of hundreds all over the country that are saving thousands of dollars in fuel annually because all their equipment and piping is correctly insulated with the right types and thicknesses of J-M Insulations.

THERE is only one way to assure maximum fuel savings and greatest operating efficiency . . . that is by using the *correct thickness* of the *right insulation* for every service.

And there is one sure way to solve the problem once and for all . . . call in a J-M Insulation Engineer. Let him study your requirements . . . if your present insulations are correct, he'll tell you so. If not, he will prepare a complete recommendation showing the most efficient and economical types and thicknesses of insulation for every piece of equipment in your plant. Furthermore, he'll be glad to prove just how they will give you better heat or refrigeration control and save you money far beyond their cost.

Back of these engineers stands Johns-Manville's 80-year leadership in the development and manufacture of insulations . . . the largest, best equipped Thermal Insulation Laboratory in the world . . . and a complete line of insulating materials in block, brick, cement and pipe-covering form for every temperature, for every service condition.

Why not phone for a J-M Engineer today? His services are free . . . and you'll find one or more in every large city throughout the country. Or, for complete details on J-M Insulating Materials, write for Brochure IN-55A. Address Johns-Manville, 22 East 40th Street, New York, N. Y.

Johns-Manville

INDUSTRIAL INSULATIONS

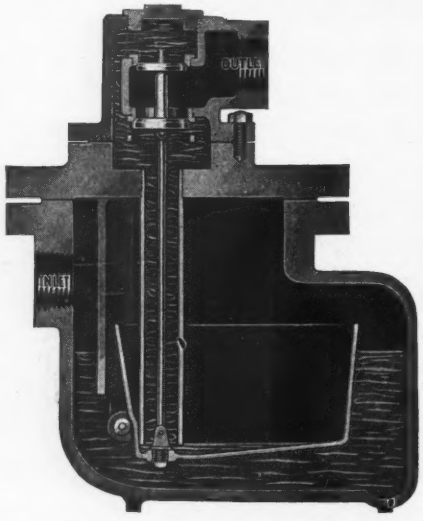
for every temperature . . . for every service condition

PIPEWRENCH PETE SAYS:

THIS TRAP HANDLES A CARLOAD OF CONDENSATE AN HOUR!

STRONG No. 50 TRAP

Capacity Over 50,000 Lbs. Per Hour!



TOUGH STEAM PROBLEMS? ...SEE STRONG FIRST!

Each of the big digesters in the southern paper mills have peak loads exceeding 2000 boiler horsepower pressures from 20 to 140 pounds. A builder of special machines needed traps for only 3 to 4 lbs. per hour. Both tough problems, but STRONG had the answer!

You'll find better answers to your toughest problems in STRONG'S complete line of open and inverted bucket traps with ANUM-METL seats and discs, guaranteed leakproof a full year.

Get a load of facts, plus an easy, practical way to size traps. Send for Catalog 63-PE8. No obligation, so write today!

CONTINUOUS BLOW-DOWN

Accurate Regulation, Long Life

Special steel valves for accurate regulation in continuous blow-down or metering service. Also new kind of assembly. Catalog 101.

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1392 West Third St., Cleveland, O.

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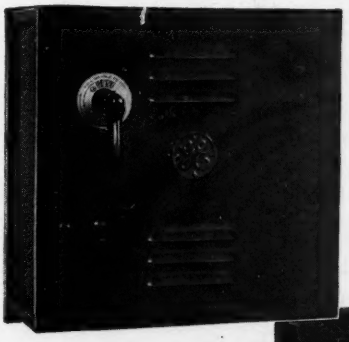
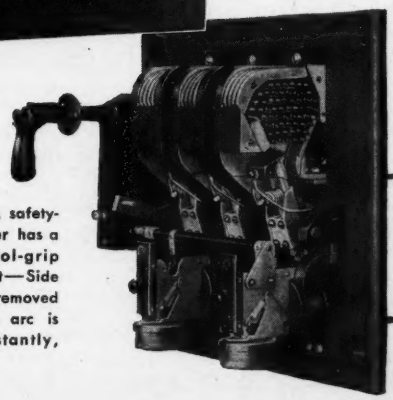
Bailey Meter Company

TODAY—BRANCH FEEDERS SHOULD BE PROTECTED WITH AIR CIRCUIT BREAKERS

AFTER the breaker operates, a turn of the handle restores power—with absolute safety





The Type AE-1A safety-enclosed breaker has a convenient pistol-grip handle. At right—Side of arc quencher removed to show where arc is smothered instantly, safely

3-phase interruption prevents motors from running single-phase, reduces repair expense, and avoids delay

PROVISION for the increased use of electricity in industrial plants has in many cases raised the possible short circuits to such a magnitude that air circuit breakers are now necessary for adequate protection of the main and branch feeders.

The Type AE-1 safety-enclosed air circuit breakers are admirably adapted to furnishing adequate protection against dangerous short circuits. Also, they provide three-phase interruption in case of dangerous over currents. Service is restored immediately by a slight movement of the handle. They are safety-enclosed for the protection of personnel. Reliable arc quenchers interrupt quickly and confine the arc. Dependable protection of cables, motors and other apparatus is assured.

In the photograph you see a workman reclosing the opened circuit by turning the pistol-grip handle—no production delays here. This feature alone means real savings in the long run. Also, a dual overcurrent device provides time-delay overload protection combined with instantaneous tripping on short circuits.

Write for Bulletin GEA-2896. It shows WHY and WHERE air breakers should be used. General Electric Company, Schenectady, New York.

GENERAL ELECTRIC

890-75

Garlock 262 SPECIAL HYDRAULIC PACKING

RESISTS WATER!

WATER rolls off GARLOCK 262 like off a duck's back! Manufactured from a very fine cotton fabric, laid up with a high-grade white friction—GARLOCK 262 Special Hydraulic Packing gives long, dependable service on inside packed plungers of pumps handling either hot or cold water. Also recommended for hot or cold oils. Illustration shows GARLOCK 262 Coil. Rings with step joint—GARLOCK 261. Solid Rings—GARLOCK 260. All sizes.

THE GARLOCK PACKING CO.
PALMYRA, NEW YORK

In Canada: The Garlock Packing Co. of Canada Ltd., Montreal, Que.

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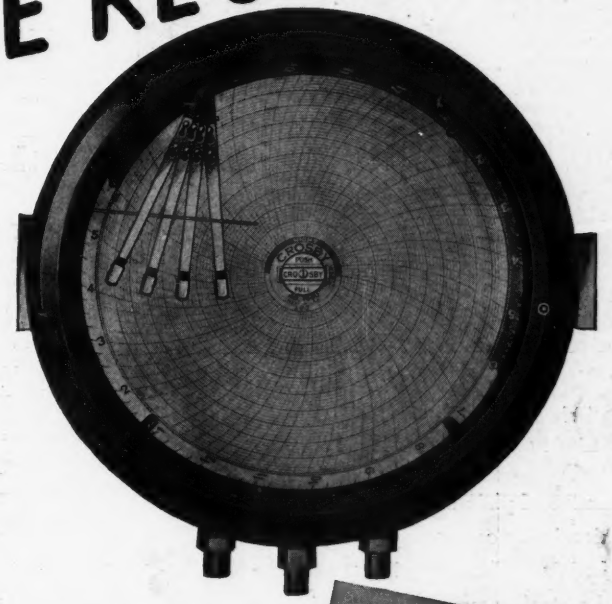
Standard Oil Co. (Indiana)
Texas Company, The
Tide Water Associated Oil Company

OILS, FUEL
Gulf Refining Company
Pure Oil Co., The
Shell Union Oil Corporation
Standard Oil Co. (Indiana)
Texas Company, The
Tide Water Associated Oil Company

OILS, LUBRICATING
Gulf Refining Company
Pure Oil Co., The
Shell Union Oil Corporation
Standard Oil Co. (Indiana)
Texas Company, The

Announcing the NEW CROSBY PRESSURE RECORDERS!



These new instruments—the result of more than half a century's experience in the design, development and manufacture of Recorders—are made in 10" and 12" sizes and in one, two, three or four pen types.

Exclusive features include:

Interchangeable Tubes

Crosby Bourdon Tubes are of rugged proportions, super-sensitive and accurate. Tubes, sockets and tips are complete units, interchangeable, easily removed and replaced for changes in pressure range.

One-piece Stainless Steel Pens

A new type of reservoir pen includes the capillary as an integral part and assures a fine, uniform line without blotting. Hod-type pens having equally fine writing characteristics are optional. Flexible Stainless Steel pen arms insure a light, even pressure on chart. May be removed or replaced without disturbing calibration.

Micrometer Calibration Adjustment

Accurate, rapid calibration is made by means of a large thumb screw which is locked in position to insure permanency of adjustment.

Micrometer Pen-Arm Adjustment

Easy, accurate and quick compensation for water leg is provided by means of an adjusting screw on each pen arm, readily accessible when the door is open.

Push-Pull Chart Hubs

Chart changing is accomplished without removing hub—by merely pulling hub forward, slipping chart in place and snapping hub back in position.

Other features offered in the New Crosby Pressure Recorders:

- ... an Automatic Pen Lifter which raises pens clear of chart when door is opened.
- ... a Time Set Indicator and Time Markers on outer edge of chart simplifying setting of chart at exact time.
- ... charts of exceptionally heavy, coated paper, practically unaffected by atmospheric conditions.
- ... either electric or spring-operated clocks available; movements enclosed in dust-proof case.
- ... cases of universal design adaptable for either flush or wall mounting.
- ... all working parts corrosion-resistant and fully protected against moisture and dust.

•

A New Bulletin — illustrating and describing the many features of Crosby Pressure Recorders is available on request. Write for a copy.

CROSBY SAFETY and RELIEF VALVES
INDICATING GAGES—GAGE TESTING INSTRUMENTS

CROSBY STEAM GAGE AND VALVE CO.
Boston, Mass.

for less...

It's a matter of plain arithmetic that the lowest cost union is the one that gives the lowest cost per tight joint. That's why Darts have the lowest final cost: they make up to tight joints again and again. For Dart bronze seats are not ordinary seats: they're ground with hairline precision to a true hall joint: extra wide spherical surfaces that match all around, *and contact all around* for repeatable, leak-proof seating. Consider too the heavy bodies and nuts of air-refined malleable iron that make Darts proof against wrench abuse and thread distortion . . . We'll put the proof right up to you: send for a Dart to try in your own plant. Write us what size.

E. M. DART MFG. CO., PROVIDENCE, R. I.

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Stephens-Adamson Mfg. Co.

PROTECTIVE COATINGS
Dampney Co. of America, The
Quigley Company, Inc.

PULVERIZED FUEL EQUIPMENT
Combustion Engrg. Co., Inc.
Foster Wheeler Corporation

PULVERIZERS
American Pulverizer Co.

PUMP PRIMING SYSTEMS
De Laval Steam Turbine Co.

PUMPS, BOILER FEED
Allis-Chalmers Mfg. Co.
De Laval Steam Turbine Co.
Gardner-Denver Company
Goulds Pumps, Inc.
Ingersoll-Rand Company
Moore Steam Turbine Corp.
Warren Steam Pump Co., Inc.

PUMPS, CENTRIFUGAL
Allis-Chalmers Mfg. Co.
Chain Belt Company
De Laval Steam Turbine Co.
Goulds Pumps, Inc.
Ingersoll-Rand Company
Moore Steam Turbine Corp.
Warren Steam Pump Co., Inc.

PUMPS, ELEVATOR, FIRE AND GENERAL SERVICE
De Laval Steam Turbine Co.
Goulds Pumps, Inc.
Warren Steam Pump Co., Inc.

PUMPS, HYDRAULIC PRESSURE
Goulds Pumps, Inc.
Warren Steam Pump Co., Inc.

PUMPS, OIL
De Laval Steam Turbine Co.
Engineer Company, The
Gardner-Denver Company
Goulds Pumps, Inc.
Manzel Brothers Company

PUMPS, POWER, ELECTRIC
Gardner-Denver Company
Goulds Pumps, Inc.
Warren Steam Pump Co., Inc.

PUMPS, TURBINE
Goulds Pumps, Inc.
Moore Steam Turbine Corp.
Warren Steam Pump Co., Inc.

PUMPS, VACUUM
Gardner-Denver Company
Goulds Pumps, Inc.
Ingersoll-Rand Company
Hoffman Specialty Co., Inc.
Warren Steam Pump Co., Inc.

PUMPS; WATERWORKS
Gardner-Denver Company
Goulds Pumps, Inc.
Moore Steam Turbine Corp.
Warren Steam Pump Co., Inc.

PURIFIERS, BOILER FEED
Elgin Softener Corporation
Sarco Company, Inc.

PURIFIERS, STEAM
Hagan Corporation
Marley Company, The

PYROMETERS
Brown Instrument Co., The
Taylor Instrument Companies

RECORDING INSTRUMENTS
Sarco Company, The
Taylor Instrument Companies

REFRACTORIES
Babcock & Wilcox Co., The
Carborundum Company, The
Forty-Eight Insulations, Inc.
Eagle-Picher Lead Co., The
Johns-Manville
Norton Company
Quigley Company, Inc.
Plibrico Jointless Firebrick Co.

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Plibrico Jointless Firebrick Co.
Quigley Company, Inc.

REFRIGERATION, WATER VAPOR FOR AIR CONDITIONING
Ingersoll-Rand Company

REGULATORS, DAMPER
Atlas Valve Company
Cash Company, A. W.
Hagan Corporation
Hays Corporation, The
Republic Flow Meters Co.

REGULATORS, FAN ENGINE
Atlas Valve Company
Foster Engrg. Company

REGULATORS, FEED WATER
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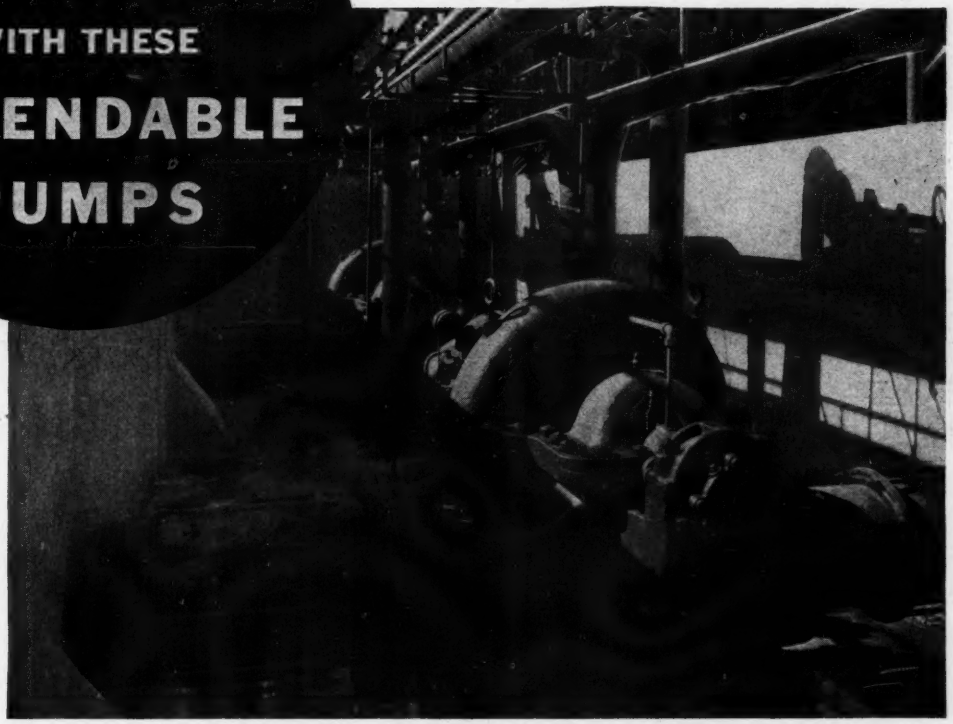
Bailey Meter Company
Chaplin-Fulton Mfg. Company
Northern Equipment Company
Republic Flow Meters Co.
Sarco Company, Inc.
Squires Company, The C. E.

LOW COSTS WITH THESE DEPENDABLE PUMPS

Fig. 3460 Double Suction Centrifugal Pump circulating water in a large Texas refinery.



When low pumping costs are a primary consideration, a Goulds Fig. 3460 double-suction centrifugal pump may well be chosen.

Goulds Centrifugal Pumps, designed for efficient and low cost performance, are giving economical pumping service under unusual operating conditions in many branches of the petroleum industry.

When, for instance, water is to be circulated in a refinery, you will find Goulds Fig. 3460 Pumps will best answer your requirements. Pumps like those illustrated have been used for years in water circulating service and have proved themselves to be highly satisfactory.

Goulds Pumps are made in many types and sizes, to meet every requirement for pumping service in refineries. Write for further information.

GOULDS PUMPS Inc.

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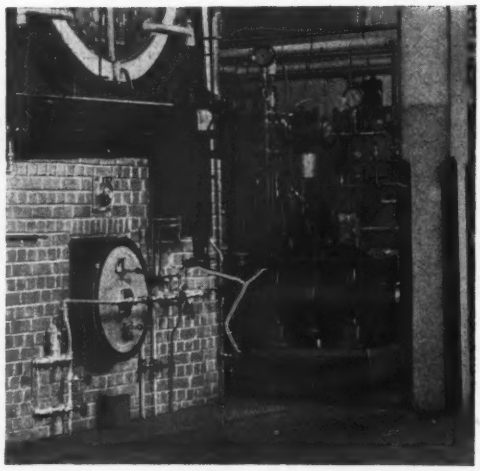
8332

Enco Burners



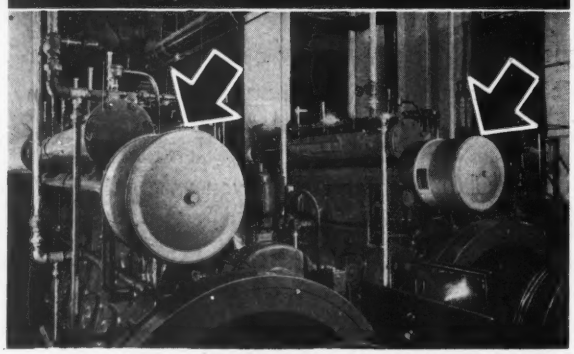
ENCO OIL BURNING EQUIPMENT
applied to a 300 H. P. Boiler.

A typical installation where all equipment and labor were supplied by ENCO and the plant turned over to the owner with undivided responsibility.

Write for Bulletin OB-37.

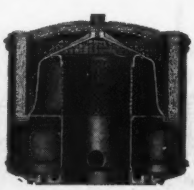
THE ENGINEER COMPANY
17 Battery Place New York, N. Y.

How to CLEAN and SILENCE Your Diesel Intake



You can silence intake noises and at the same time remove all dust with the Burgess IRCF Intake Silencer and Air Cleaner without unduly restricting the flow of intake air. Write, Burgess Battery Co., Acoustic Div., Dept. PE, 500 W. Huron St., Chicago.

In England—Burgess Products Co., Ltd., Barwell, Leicester



BURGESS

Where to Buy DIRECTORY

REGULATORS, PRESSURE
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Foster Engrg. Company
Hagan Corporation
Northern Equipment Company
Republic Flow Meters Co.
Sarco Company, Inc.
Squires Co., The C. E.
Strong, Carlisle & Hammond Co., The

REGULATORS, TEMPERATURE
Atlas Valve Company
Foster Engrg. Company
Sarco Company, Inc.
Taylor Instrument Cos.

RUST PREVENTIVES
Dearborn Chemical Company

SCALE REMOVERS, MECHANICAL
Elliott Co.
Roto Co., The
Wilson, Inc., Thomas C.

SCALE REMOVING COMPOUNDS
American Sand-Banum Co., Inc.
Betz, W. H. & L. D.
Dearborn Chemical Company

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Gardner-Denver Company
Hagan Corporation
Marley Company, The
Strong, Carlisle & Hammond Co., The
Williams Valve Co., The D. T.,

SILENCERS
Burgess Battery Company

SODIUM ALUMINATE
Dearborn Chemical Company
National Aluminate Corporation

SOOT BLOWERS
Bayer Company, The

SPRAY COOLING EQUIPMENT
Marley Company, The
Yarnall-Waring Company

SPEED INDICATORS
Biddle Co., James G.

SPEED REDUCERS
Philadelphia Gear Works
Stephens-Adamson Mfg. Co.

SPRINKLERS
Grinnell Company, Inc.

SPROCKET RIMS
Babbitt Steam Specialty Co.

SPROCKET WHEELS
Philadelphia Gear Works

STACKS, METAL
Vogt Machine Co., Inc., Henry

STEAM TRAPS
American District Steam Co.
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Crane Co.
Davis Regulator Co.
Hoffman Specialty Co., Inc.
Sarco Company, Inc.
Squires Co., The C. E.
Strong, Carlisle & Hammond Co., The
Williams Valve Co., The D. T.
Yarnall-Waring Company

STOKERS, MECHANICAL, OVERFEED AND GRATE
American Coal Burner Company
American Engrg. Company
Babcock & Wilcox Co., The
Combustion Engrg. Co., Inc.
Detroit Stoker Company
Flynn & Emrich Co.
Westinghouse Elec. & Mfg. Co.

STOKERS, SPREADER
American Coal Burner Company

STOKERS, UNDERFEED
American Engrg. Company
Combustion Engrg. Co., Inc.
Detroit Stoker Company
Flynn & Emrich Co.
Westinghouse Elec. & Mfg. Co.

STRAINERS
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Davis Regulator Co.
Sarco Company, Inc.
Strong, Carlisle & Hammond Co., The

SUPERHEATERS, STEAM
Babcock & Wilcox Co., The
Combustion Engrg. Co., Inc.
Edge Moor Iron Works, Inc.
Foster Wheeler Corporation
Marley Company, The

SWITCHBOARDS
General Electric Company

TACHOMETERS
Biddle Co., James G.
Brown Instrument Co., The

TANKS
Edge Moor Iron Works, Inc.
Vogt Machine Co., Inc., Henry

THERMOMETERS, DIAL
Sarco Company, Inc.

THERMOMETERS, RECORDING, INDICATING
Brown Instrument Co., The
Taylor Instrument Companies

TILE CONDUIT, FOR STEAM LINE
American District Steam Co.

TOOLS
Snap-On Tools Corporation

TOOLS, PNEUMATIC
Ingersoll-Rand Company

TRAPS, COMPRESSED AIR, VACUUM
American Blower Corporation
Armstrong Machine Works
Sarco Company, Inc.
Strong, Carlisle & Hammond Co., The

TRAPS, STEAM, RADIATOR AND RETURN
American Blower Corporation
American District Steam Co.
Armstrong Machine Works
Hoffman Specialty Co., Inc.
Sarco Company, Inc.
Strong, Carlisle & Hammond Co., The
Yarnall-Waring Company

TRY COCKS
Ernst Water Column & Gage Co.

TUBE CLEANERS, BOILER AND CONDENSER
Elliott Company
Roto Company, The
Wilson, Inc., Thomas C.

TUBING
Pittsburgh Steel Company

TUBING, SEAMLESS STEEL
Pittsburgh Steel Company

TURBINES, STEAM
Allis-Chalmers Mfg. Co.
De Laval Steam Turbine Co.
Elliott Company
General Electric Company
Moore Steam Turbine Corp.
Murray Iron Works Co.
Sturtevant Company, B. F.
Terry Steam Turbine Co., The
Westinghouse Elec. & Mfg. Co.

UNDERGROUND HEATING SYSTEMS
American District Steam Co.
Johns-Manville

UNIONS
Atlas Valve Company
Crane Co.
Dart Mfg. Co., E. M.
Edward Valve & Mfg. Co., Inc., The

VALVE CONTROL EQUIPMENT
Philadelphia Gear Works

VALVE DISCS
Fairbanks Company, The
Garlock Packing Company
Goetze Gasket & Packing Co.
Jenkins Bros.
United States Rubber Co.

VALVES, AUTOMATIC CUT-OFF
Northern Equipment Company

SAMCO, The Cost-Cutter Asks:

IS YOUR COAL HANDLING EQUIPMENT PROPERLY TAILORED?

You'll find that when your Coal and Ash Handling Equipment is "tailored to fit", by Stephens-Adamson Engineers, your conveying-elevating-screening and power transmission costs will be reduced to their absolute minimum.

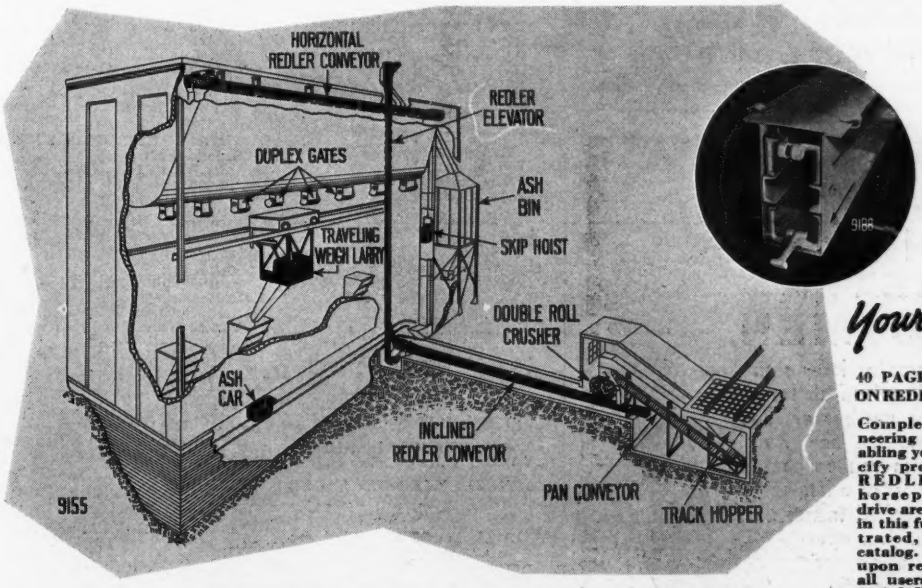
Every job built by S-A is designed with one goal in mind: *To handle the required tonnage over longer periods, at lowest possible cost per ton.*

Only with our capable engineering staff, complete manufacturing facilities for *all types* of Material Handling Equipment, and our determination to maintain quality are we able to achieve this goal.

Symbolic of S-A engineering advancement with new Material Handling methods, is the REDLER Conveyor-Elevator, for conveying-elevating *en masse*, coal and other pulverized, granular and small lump materials.

Take advantage of reliable S-A recommendations.

Write us about your Material Handling problem!



●**Note the *compactness* of the REDLER Conveyor-Elevators in this typical S-A Power Plant. REDLERS *convey* coal and other pulverized, granular and small lump materials, *en masse, in any direction*. REDLERS are *dust-tight, self-feeding* and *self-cleaning*.**

CONVEYING • ELEVATING • SCREENING • TRANSMISSION EQUIPMENT

STEPHENS-ADAMSON MANUFACTURING COMPANY

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LOS ANGELES, CAL. AURORA, ILLINOIS BELLEVILLE, ONTARIO.

Yours for the Asking

40 PAGES OF ENGINEERING DATA ON REDLER CONVEYOR-ELEVATORS

Complete Engineering data enabling you to specify proper size REDLER and horsepower of drive are included in this fully illustrated, 40-page catalog. Sent free upon request to all users of Material Handling Equipment.

STEPHENS-ADAMSON MFG. CO.
AURORA, ILLINOIS (PPE 12)

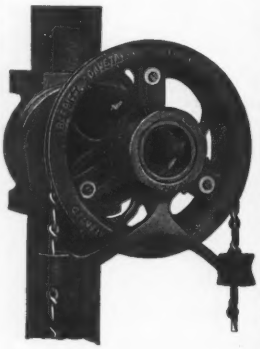
We would like copy of your 40-page engineering catalog on REDLER CONVEYOR-ELEVATORS..... ☐

Send us your 120-page handbook on Belt Conveyors, Bucket Elevators and auxiliary equipment..... ☐

NAME.....

ADDRESS.....

Do Away with Dangerous LADDER WORK



Stop climbing ladders to open and close those "high-up" valves. Equip them with Babbitt Sprocket Rims and you can control them quickly and safely from the floor. Babbitt Rims are easily attached and low in cost. They show real savings in time and steam—help guard against accidents. Now is the time to fit your overhead valves with Babbitt Rims. Write today for further information.

BABBITT STEAM SPECIALTY CO.
New Bedford, Mass., U. S. A.

Babbitt
—Adjustable—
SPROCKET RIM
with Chain Guide

New ROTO AIR VALVE SAVES TIME & LABOR

ONE MAN Cleans Tubes FASTER Than TWO MEN

Count the time your operator loses signalling his helper to turn on and shut off air for each tube. Multiply it by the number of tubes cleaned. That's the time the new Roto Operating Air Valve saves you on each job. And you save the cost of a helper too. With this valve attached immediately behind the motor, your operator starts and stops the cleaner himself—instantly. A quarter turn either way does the trick. Valve can't close inside tube. Made for all makes of cleaners for straight and curved tubes 2" or larger. But with the Roto Senior Tube Cleaner, the combination is unbeatable for power, endurance and SPEED.

Model 125 Roto Tube Cleaner for 3" Curved Tubes.

SEE OUR ADV. IN SWEET'S

WRITE FOR DETAILS
The ROTO Company
145 Sussex Ave., Newark, N. J.

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Foster Eng'r'g Company

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Foster Engrg. Company

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Crane Co.
Crosby Steam Gage & Valve Co.
Edward Valve & Mfg. Co., Inc., The
Fairbanks Company, The
Homestead Valve Mfg. Co.
Jenkins Bros.
Powell Co., The Wm.
Reading-Pratt & Cady Division
Yarnall-Waring Company

VALVES, CHECK
Chapman Valve Mfg. Co., The
Crane Co.
Crosby Steam Gage & Valve Co.
Edward Valve & Mfg. Co., Inc., The
Fairbanks Company, The
Hoffman Specialty Co., Inc.
Jenkins Bros.
Kennedy Valve Mfg. Company
Lunkenheimer Co., The
Powell Co., The Wm.
Reading-Pratt & Cady Division
Williams Valve Co., The D. T.

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Brown Instrument Co., The
Fairbanks Company, The
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Cash Company, A. W.
Crosby Steam Gage & Valve Co.
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Crane Co.
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Grinnell Company, Inc.
Hoffman Specialty Co., Inc.
Jenkins Bros.
Kennedy Valve Mfg. Company
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Powell Co., The Wm.
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Vogt Machine Co., Inc., Henry
Williams Valve Co., The D. T.

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Homestead Valve Mfg. Co.
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Foster Engrg. Company

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Jenkins Bros.
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Fairbanks Company, The
Jenkins Bros.
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Hagan Corporation
Northern Equipment Company
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Squires Co., The C. E.
Strong, Carlisle & Hammond Co., The

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Chain Belt Company

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Cochrane Corporation
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Crosby Steam Gage & Valve Co.
Lunkenheimer Co., The

WRENCHES
Snap-On Tools Corporation

CRYSTOLON BRICK

Clean as a Whistle after Three Years of Service

THIS unretouched photograph shows an installation of Crystolon Brick after three years of service. Clinkers and slag have not adhered to the hard, dense surface of these Norton silicon carbide brick. Their resistance to high temperature and to abrasion assures many more years of service.

RC-1133 CEMENT

Has lasted longer than any previous bridge wall

AN unretouched photograph of a bridge wall of RC-1133 Cement after months of service—and still good for many more. Previous materials sometimes gave a service life of only a few weeks. RC-1133 is an economical silicon carbide cement that can be used for complete linings or for patching.

NORTON COMPANY, WORCESTER, MASS.
New York Chicago Cleveland

R-608

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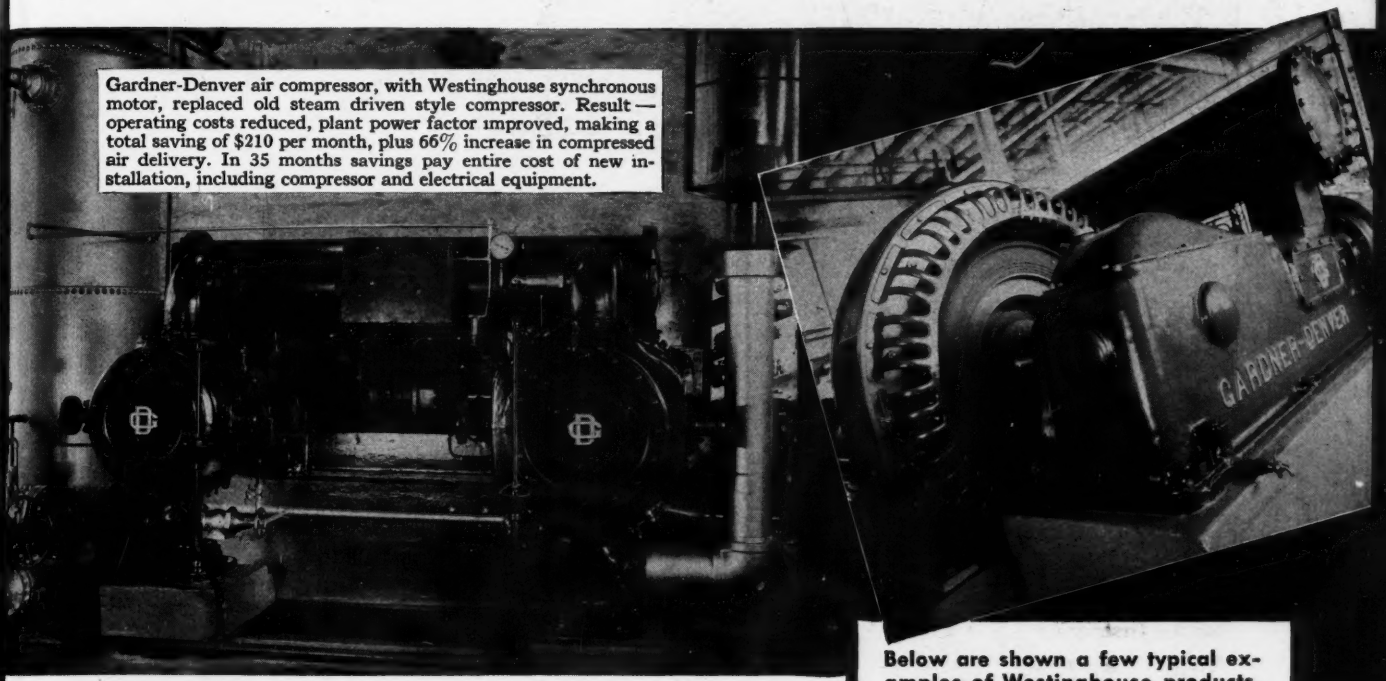
EXAMPLES OF PRACTICAL PARTNERSHIP IN CONVERTING ***POWER*** INTO ***PROFIT***

SAVES $210 EVERY MONTH

WITH WESTINGHOUSE-DRIVEN AIR COMPRESSOR!



Gardner-Denver air compressor, with Westinghouse synchronous motor, replaced old steam driven style compressor. Result — operating costs reduced, plant power factor improved, making a total saving of $210 per month, plus 66% increase in compressed air delivery. In 35 months savings pay entire cost of new installation, including compressor and electrical equipment.

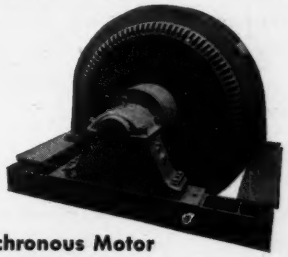
New equipment delivers 66% more air, yet costs less to operate than old-type compressor.

This compressed air installation, in a large midwestern industrial plant, again proves the value of replacing outmoded or worn-out machinery with modern equipment. When savings pay entire cost of new installation in 35 months, that's a good investment!

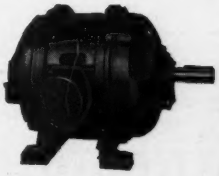
Westinghouse engineers constantly co-operate with machinery builders and customers in designing drives to match increased efficiency of new equipment. Together they analyze the problems — and find the profitable answers. And thus provide more examples of Westinghouse co-operation in turning power into profits.

The same engineering skill is available to you. Westinghouse will work with you and your machinery builders to reduce costs and increase production with modern electrical equipment. See your local Westinghouse office, or write to Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa. Address Dept. 7-N. J-93913

Below are shown a few typical examples of Westinghouse products, to meet your electrical requirements from power supply to driven machine.

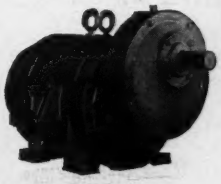


Synchronous Motor



CS Induction Motor

Combination Linestarter and Circuit Breaker

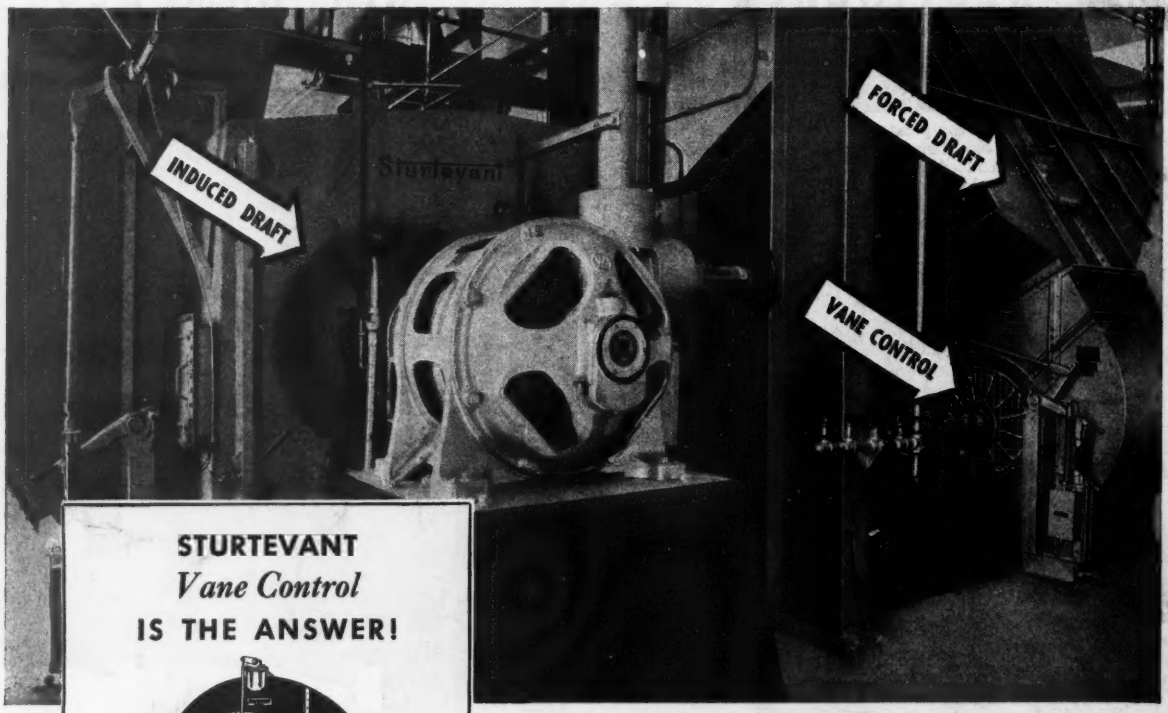


Gearmotor

Westinghouse

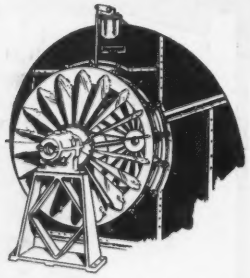
ELECTRICAL PARTNER OF INDUSTRY

Draft Fans THAT SAVE MOTOR AND OPERATING COSTS



Sturtevant Vane-Controlled Mechanical Draft Fans installed in plant of Southern Alkali Corp., Corpus Christi, Texas. G.R. Avery, Superintendent of Steam and Power Department.

STURTEVANT
Vane Control
IS THE ANSWER!



In Sturtevant Vane Controlled Mechanical Draft Fans pressure and volume are regulated by *movable vanes*, as illustrated above, which are located in the fan inlets. These vanes are operated either manually or by automatic combustion control.

As a result, quick, accurate response to varying load requirements is assured.

Sturtevant Vane Control combines the flexibility and immediate response of dampers with the efficiency of variable speed control.

Selected by Southern Alkali Corp. for new 150,000 lb. per hour boiler

To meet increased load requirements, one 150,000 lb. per hour B & W Boiler recently was installed in the Corpus Christi, Texas Plant of the Southern Alkali Corp.

Sturtevant Patented Vane Controlled Draft Fans (one Forced Draft and one Induced Draft) were selected to serve this boiler, because:

1. **They permit use of constant speed motors instead of more costly variable speed motors.**
2. **They eliminate the expensive and complicated control required for variable speed motors.**
3. **They assure high efficiency.**
4. **They reduce motor power consumption.**
5. **They assure quick, accurate regulation of pressure and volume.**

Sturtevant
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Puts Air to Work

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